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STOCK IDENTIFICATION OF COLUMBIA RIVER CHINOOK SALMON AND STEELHEAD TROUT

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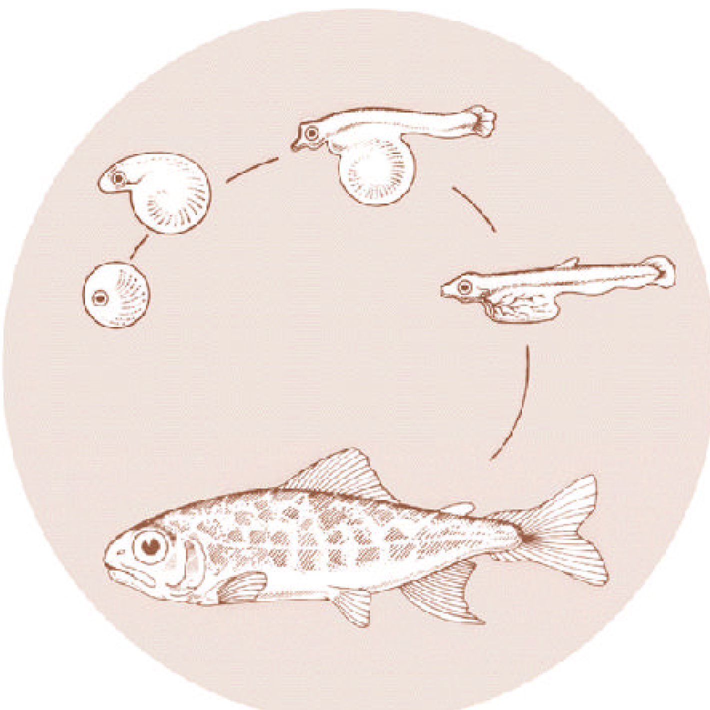

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ANNUAL PROGRESS REPORT

STOCK IDENTIFICATION OF COLUMBIA RIVER CHINOOK SALMON AND STEELHEAD TROUT

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PREFACE

The following is an annual report for the "Stock Identification of Columbia River Chinook Salmon and Steelhead Trout" study funded by Bonneville Power Administration. The Introduction and Methods sections were written as though the project was complete and thus refer to events in past tense, some of which have not been completed.

The Results and Discussion section contain the analyses of the data that is available atthistime. Because this is an ongoing project and subject to change, Figure 1, which will be a map of the study area, has not been included.

ABSTRACT

Fish were collected from 60 stocks of chinook salmon and 62 stocks of steelhead trout. Electrophoretic analyses were completed on 43 stocks of chinook salmon and 41 stocks of steelhead trout and meristic counts were completed on 43 stocks of chinook and 41 stocks of steelhead.

Statistical comparisons between year classes of our electrophoretic data indicate that most enzyme systems are stable over time but some may be dynamic and should be used with caution in our analyses. We also compared neighboring stocks of both spring chinook and steelhead trout. These comparisons were between stocks of the same race from adjacent stream systems and/or hatcheries. Differences in isozyme gene frequencies can be used to estimate genetic segregation between pairs of stocks. Analysis of the chinook data suggests that, as expected, the number of statistically significant differences in isozyme gene frequencies increases as the geographic distance between stocks increases. The results from comparisons between adjacent steelhead stocks were inconclusive and must await final analysis with more data.

Cluster analyses using either isozyme gene frequencies or meristic characters both tended to group the chinook and steelhead stocks by geographic areas and by race and both methods resulted in generally similar grouping patterns. However, cluster analyses using isozyme gene frequencies produced more clusters than the analyses using meristic characters probably because of the greater number of electrophoretic characters compared to the

number of meristic characters.

Heterozygosity values for each stock were computed using the isozyme gene frequencies. The highest heterozygosity values for chinook were observed in summer chinook and the hatchery stocks while the lowest values were observed in the spring chinook and wild stocks. The results of comparisons of heterozygosity values among areas were inconclusive. The steelhead heterozygosity values were higher in the winter stocks than in the summer stocks and similar between hatchery and wild stocks. Heterozygosity values among the areas were very similar for the steelhead stocks.

Analysis of variance tests indicate that significant differences exist among the stocks for scales in the lateral series, scale rows above the lateral line, anal rays, dorsal rays, vertebrae and paired fin rays for both steelhead and chinook. Tests on gill raker and branchiostegal counts will be conducted when those counts are completed.

Morphometric characters were compared between fed and starved groups of steelhead trout to determine which characters may be affected by condition factor or fatness of the fish. The results show that the linear characters, some head measurements and the truss-type characters in the caudal peduncle are most likely to be unaffected by condition factor. The measurements in the gut area of the fish appear to be unsuitable for discriminating among the stocks since they are highly affected by condition factor.

STOCK IDENTIFICATION OF COLUMBIA RIVER CHINOOK SALMON AND STEELHEAD TROUT

INTRODUCTION

Stock identification has become an accepted management tool in fisheries, particularly for species that return to their natal areas to spawn. For anadromous salmonids, the tendency to return to natal streams reduces gene flow and allows the individual stocks to adapt to specific stream systems.

The important concerns addressed by the stock concept include proper management of exploited fish populations (Radcliffe 1928; Royal 1953), protection of gene pools (Behnke 1972; Gall 1972), and productivity of introduced and native fish populations (Ricker 1972; Reisenbichler and McIntyre 1977). The maximum productivity of a complex river system should be achieved when several stocks are present, each with co-adapted gene systems for maximum fitness (Loftus 1976). Utilizing the stock concept for managing the harvest of exploited species provides opportunity for greater harvest of underutilized stocks while protecting stocks that are at low levels of abundance, provided that it is possible to identify the individual stocks (Larkin 1981; Altukhov and Salmenkova 1981; McDonald 1981). Preservation of the gene pools is important for maintaining the genetic diversity and thus the adaptive potential of a species. Wild stocks may be particularly important gene resources in view of the potential loss of genetic diversity through inbreeding and selection (Allendorf and Phelps 1980) and the possible lower vitality of hatchery stocks (Ihssen 1976, Thorpe 1980). The productivity of introduced stocks is related to the degree of adaptation to the recipient stream systems. Introduced stocks that are genetically similar to the native stocks should theoretically have a higher survival rate than stocks that are dissimilar. The failure of some introduced stocks can be attributed to poor adaptation (Cleaver 1968, Ricker 1972, Baas 1976, Saunders 1981). Introduced stocks could also potentially harm the native stocks through introgression and thus reduce the productivity of the wild stock (Reisenbichler and McIntyre 1977; Altuhkov 1981; Ryman and Stahl 1981).

The concerns addressed by the stock concept are particularly important to the Columbia River fisheries where many of the stocks have been lost or are at low levels of abundance because of overharvest, habitat degradation, or hydroelectric dams. In addition, the relationships among the stocks has been altered by hatchery production and transfers of stocks within the basin. In light of the susceptibility of salmonid stocks to genetic changes and loss of overall diversity (Thorpe etal.l981),itis very important to identify the existing stocks and the relationships among the stocks in the Columbia River Basin,

Our purpose was to identify stocks of Columbia River steelhead trout (Salmo gairdneri) and chinook salmon (Onchorhynchus tshawvtscha) in such a way as to assist fishery managers in selecting hatchery stocks and protecting wild stocks. We identified the stocks in a systematic way by utilizing a wide variety of genetically related characters and we explored the relationships between the stock characteristics and characteristics of the stream system. The genetically related characters provide an estimate of the total genome of each stock, and the relationships between the stocks and their stream characteristics will help fishery managers understand the potential environmental forces affecting the observed stock diversities.

The stock characteristics examined included life history, biochemical and morphological characters. The advantages and disadvantages of these characters for describing stocks of fish were discussed by Ihssen et al. (1981a). Similar studies, using a variety of characters, have been conducted on lake whitefish (Coregonus clupeaformis) (Loch 1974; Casselmann et al. 1981; Ihssen et al. 1981b), sockeye salmon (O. nerka) (Vernon 1957), and coho salmon (O. kisutch) (Hjort and Schreck 1982).

The characters evaluated by us have a genetic basis. Allendorf and Utter (1979) have reviewed evidence for the genetic basis for biochemical characters. The biochemical characters that we used in this study are given in Table 1. The life history characters include time of entry into fresh water, time of spawning, and age at spawning. Hypotheses have been proposed to explain the significance to stock fitness of life history characters for both Atlantic salmon (Salmo salar) (Schaffer and Elson 1975) and steelhead trout (Withler 1966; Biette et al. 1981). Ricker (1972) has reviewed the evidence for a genetic component in time of entry into fresh water for chinook. Evidence for a genetic component in time of spawning has been given by Donaldson (1970) for chinook salmon, while Garrison and Rosentreter (1981), and Ayerst (1977) have provided similar evidence for steelhead trout. The age of spawning also has a genetic basis in chinook salmon as reviewed by Ricker (1972) and in rainbow trout as evidenced by Lewis (1944), Millenbach (1950), Donaldson and Olson (1955), and Ayerst (1977). We looked at 14 morphometric and six meristic characters. Riddel et al. (1981) demonstrated a genetic basis for body shape and fin length in Atlantic salmon and a plausible adaptive basis for these characters was provided by Riddell and Leggett (1981). A genetic basis, as shown in the steelhead-rainbow series, has also been established for number of vertebrae (Winter et al. 1980), scales in the lateral series (Winter et al. 1980), scale rows (Neave 1944), gill rakers (Smith 1969), branchiostegals (MacGregor and MacCrimmon 1977), and fin rays (MacGregor and MacCrimmon 1977). Ricker (1972) hypothesized that the meristic characters of salmonids probably have both genetic and environmental components. While it is difficult to determine the importance of these phenotypic characters to the fitness of the stocks, meristic characters could still have, through selection or pleiotropic effects, a bearing on the fitness as suggested by Barlow (1961) and thus they may serve as genetic markers. The heritability of meristic characters is extremely high (Fred Allendorf, pers. coma.).

The stocks of steelhead trout and chinook salmon that were identified for inclusion in this study were selected so that comparisons could be made among geographical areas, among stream types, between hatchery and wild stocks, and between transplanted stocks and the original donor stock.

We calculated a measure of phenotypic similarity and used cluster analysis to display the relationships among the stocks. Because cluster analyses are arbitrary (Blackith and Reyment

1971) we used two clustering strategies to cluster phenotypically similar stocks. We wanted to determine if similar types of streams produce phenotypically similar stocks. Each cluster of phenotypically similar stocks was characterized by determining environmental characteristics common to the stream systems of the stocks in that cluster.

METHODS

We evaluated characters for hatchery and wild stocks of steelhead trout and chinook salmon from the Columbia River Basin in Oregon, Washington and Idaho. We reviewed hatchery records and interviewed fish biologists to' determine the history of each stock and classified the stocks as wild (reproducing in streams with little or no record of stock transfers into the area of collection), hatchery stocks, introduced wild stocks (stocks with a history of receiving fish from another stream system), and introduced hatchery stocks (stocks in hatcheries with a history of receiving fish from another stream system), We classified the introduced stocks further by attempting to estimate the relative composition of each stock as either pure or mixed. This was based on the number of introductions and the presence of native wild or original hatchery stock. These classifications helped us to determine whether the characteristics reflected environmental factors or introgression of foreign genotypes.

Morphological Characters

Twenty fish from each sample were stored frozen for later analysis. Scales in the lateral series were counted on the left side in the second row above the lateral line, starting with the anteriormost scale and terminating at the hypural plate. Scales above the lateral line were counted from the anterior insertion of the dorsal fin to the lateral line. Anal rays were counted and did not include the short rudimentary anterior rays, and branched rays were counted as one. The number of gill rakers on the upper portion of the left first arch was recorded. Alizarin red was used to highlight rudimentary gill rakers. The total number of branchiostegal rays on both sides was recorded. Vertebral counts, made on X-ray plates, included the last three upturned centra. Trout were examined for the presence of basibranchial teeth.

The morphometric measurements follow those of Casseltnan et al. (1981) except for head width and snout to anterior insertions of the pectoral and pelvic fins which follow Riddell and Leggett (1981). We also measured the distance from the snout to the anterior insertion of the anal and dorsal fins.

Landmark points on the fish were highlighted, when necessary, using insect pins (eg. fin insertions) or small strips of white paper (eg. tip of maxillary) (Figure 1) and each fish was arranged and photographed on a flat surface with a ruler included in each frame. We then used a digitizer to record the X - Y coordinates of each landmark on all photographs. We accounted for differences in magnification by using a known distance on the ruler in each photograph to convert photograph X - Y coordinates to "real" X - Y coordinates. The various measurements were then calculated using the Pythagorean Theorom and the coordinates of the appropriate landmark points. We included both classical and truss-type measurements similar to those found in Winans (1984) (Figure 2).

We determined the effects of condition factor on morphometric measurements of juvenile steelhead trout to determine which morphometric characters are invalid for comparing fish from different environments (eg. hatchery vs. wild). We made morphometric measurements on Alsea hatchery steelhead trout that had been treated in one of two ways. We sampled the fish while they were on a feeding schedule comparable to that of most hatcheries, A second group of fish was starved starting at the same time that the first group of robust fish was sampled. When these starved fish reached a condition factor approximating that of wild fish, they too were sampled. This produced fed and starved groups of approximately the same average length. The morphometric measurements were carried out using the digitizer board and the methods listed above. We divided each measurement by the standard length to adjust the values for differences in length within each group and then tested for equality of the two treatments with t-tests.

Electrophoresis

White muscle (1 cm^3 from the anterior epaxial section of each fish), liver and eye samples were cut from those fishthatwere not used for meristic and morphological evaluation. The tissue samples were homogenized with 2-3 drops of water and then centrifuged to clear the supernatent. The methodology for the starch gel electrophoresis of the supernatent followed that of Utter et a1.(1974) and Allendorf et al. (1977). The nomenclature for the enzyme systems (Table 1) analyzed in this study followed that of Allendorf and Utter (1979).

Life History

The life history characters we used were time of entry into fresh water, time of peak spawning, and age at spawning. We estimated these parameters through interviews with district biologists and hatchery managers and by reviewing the literature. We stratified the time of entry into fresh water and the peak spawning times into 2-week segments. Because commercial fisheries have reduced the average size and age of Pacific salmon (Van Hyning 1968; Ricker 1981), we did not use age at spawning as a characteristic of chinook salmon.

Environmental Data

The stream characteristics evaluated included distance from the mouth of the Columbia to the spawning grounds, basin area, gradient, time of peak water discharge, and other species of fish present in the rearing areas. To separate the populations that have short and long swimming distances to the spawning areas, we measured the distance from the mouth of the Columbia to the spawning grounds in each stream system. Gradients were calculated from the mouth of the stream system to the upper limit of spawning as a basis for estimating the difficulty of the spawning migration. We measured the stream elevations and distances on United States Geological Survey quadrangle maps. Inasmuch as high flows could have an effect on both early life history and the smolting processes of juvenile salmonids, we determined the historical peak of water discharge from interviews and literature surveys. We determined which other fish species were present in each stream system through interviews, literature, and direct observation while making our collections.

We obtained temperature data from hatchery records to help interpret the meristic counts for the hatchery stocks. The average temperature for the first month of incubation was used because previous studies have indicated that this time is a period during ontogeny when meristic features may be most sensitive to the effect of temperature (Taning 1952).

Statistics

We calculated averages for the morphological characters, enzyme gene frequencies, and the proportion of females for each stock, and used multivariate analysis of co-variance to determine whether morphological characters differed significantly among stocks. Standard length was the co-variate for the body measurements. Body measurements were converted to common logarithms for the reasons listed by Misra and Ni (1983). Because environmental data on spawning distance, estuary length, estuary size, basin area, and gradient were skewed, we transformed them to natural logarithms to stabilize the variance and improve normality. We standardized the characters of stocks ($z = 0$, $s = 1$) for the cluster analyses using the standard normal standardization. This standardization expresses the stock character as standard deviations from the character mean, thus giving equal weight to each character. We used Euclidian distance as a distance measure for the meristic characters and correlation coefficients between stocks for the electrophoretic data.

We calculated correlation coefficients (Snedecor and Cochran 1967) between the stock characters and the morphological characters and the temperature data for hatchery stocks only. The levels of significance for the correlation coefficients were also calculated as described by Snedecor and Cochran (1967).

Individual enzyme gene frequencies were compared between stocks with the chi-square 2 x N (N= the number of isozymes in the enzyme system) contingency table (Snedecor and Cochran 1967). The comparisons include: 1) comparisons between year classes to determine the stability of isozyme gene frequencies through time; and 2) neighboring or sympatric stocks that we might expect to be closely related. These comparisons include hatchery versus wild fish, winter versus summer steelhead, and stocks from neighboring stream systems or hatcheries.

We used cluster analysis programs to display similarities among stocks. One program, a nonhierarchical divisive cluster analysis, minimized the total sum of squares between observations and the cluster means (McIntire 1973). In the other, a hierarchical agglomerative cluster analysis, Euclidian distance was used as the dissimilarity measure, and the clustering strategy was group average (see Sneath and Sokal [1973] or Clifford and Stephenson [1975] for terminology). Standardized data were used in both programs.

Canonical variate analysis was used to investigate the relation among the clusters from the agglomerative cluster analysis (Clifford and Stephenson 1975). Canonical variate analysis produces canonical variables that project groups of multivariate data onto axes separating the groups as much as possible. We plotted the canonical variables against each other in two-dimensional space to determine the relationships among clusters and the discreteness of the clusters.

Analysis of variance was used to test for equality of the meristic counts among the stocks. We tested the effects of condition factor on morphometric measurements with analysis of variance. In these tests the variables were the morphometric measurements divided by the standard length and the treatments were fed and unfed groups of steelhead.

We calculated relative heterozygosity values from the electrophoretic data using the formula:

$$\text{Heterozygosity} = 1 - \left(\frac{\Sigma x_i^2}{N}\right)$$

N = number of loci

x_i = frequency of the i^{th} allele in the population

These values are relative heterozygosity values since we only used the loci that were polymorphic for at least one population.

RESULTS AND DISCUSSION

Electrophoretic Data

Chisquare analysis

Electrophoretic analysis of 43 stocks of chinook salmon and 41 stocks of steelhead trout has been completed (Tables 2 and 3). We conducted two types of comparisons using chi square contingency tables. In the first type we estimated the stabilities of isozyme gene frequencies through time by comparing different year classes of the same stock. In the second type of analysis we used our data to determine if there were differences in isozyme frequencies between stocks that we might expect to be similar. We compared stocks of the same race (eg. spring chinook) that were either in close proximity to each other, such as in neighboring streams or hatcheries, or they were hatchery and wild fish in the same stream system.

We found that for both steelhead and chinook, most of the isozyme gene frequencies are stable overtime but a few may be dynamic and should be used with caution in our final analysis. Isozyme gene frequencies were compared between 1983 and 1984 year classes of four stocks of spring chinook and six stocks of steelhead (Tables 4 and 5). As noted in last year's report, some isozyme gene frequencies may change over time, but for most systems the genotypes were fairly similar between year classes. The isozyme gene frequencies were compared between wild spring chinook collected in 1983 and 1984 from the Grande Ronde, Imnaha, Wallowa, and Methow rivers. These stocks differed significantly ($P = 0.05$) between year classes for phosphoglycerate kinase-2 (PGK-2) and leucylglycylglycine peptidase (LGG) in two of the comparisons, Imnaha and Wallowa for PGK-2 and Grande Ronde and Methow for LGG. PGK-2 is a highly variable system that ranges among stocks from 100% of the common allele to 100% of the variant. Random variation or selection may be the cause of the statistically significant differences between year classes.

We compared the isozyme gene frequencies between 1983 and 1984 for six stocks of steelhead: Thomas Creek and Calapooya River winter steelhead and Yakima, Grande Ronde, Imnaha and

Wallowa River summer steelhead (Table 5). We found statistically significant differences between year classes for isocitrate dehydrogenase (IDH-34) in the comparison of Imnaha, Grande Ronde, Thomas Creek and Calapooya stocks. Aconitase (ACO) was statistically different between year classes for the Yakima, Wallowa and Thomas Creek stocks. Superoxide dismutase (SOD) was statistically different for the Imnaha, Yakima and Calapooya stocks, and malate dehydrogenase-3,4 (MDH-34) was statistically different for the Thomas Creek and Calapooya River steelhead. Each of these enzyme systems are highly variable and may be more dynamic than other systems due to randon drift or selection.

Adjacent Stocks

The number of enzyme systems with statistically significant differences in isozyme gene frequencies appears to increase as the potential for genetic segregation between two stocks increases.

We made comparisons between adjacent stocks of the same race from neighboring streams and/or hatcheries that we might expect to be similar for 17 pairs of spring chinook stocks and 27 pairs of steelhead stocks (Tables 6 and 7). The comparisons include hatchery stocks that have been used in several different locations such as Carson spring chinook and Skamania summer steelhead and stocks from geographically close stream systems such as the lower Snake River tributaries, upper Columbia tributaries and the Willamette River tributaries. Any statistically significant differences in isozyme gene frequencies would suggest either that the stocks are genetically segregated or, if selection is assumed, that the environments of the individual stocks are different. The lowest number of statistically significant differences in isozyme gene frequencies for spring chinook included comparisons within stream basins and comparisons between stocks in the upper Columbia River. The comparisons within stream basins included the those among North Fork, Middle Fork and Mainstem of the John Day River and between the Grande Ronde and the Wallowa/Lostine Rivers. These stocks are all geographically close together and thus may have more straying between stocks. More statistically significant differences in isozyme gene frequencies were found between stocks for tributaries of the lower Snake River and also between hatchery and wild stocks from the same stream system. While these results are preliminary they are predictable in that more statistically significant differences in isozyme gene frequencies occur as the potential for genetic segregation becomes greater,

In the comparison of geographically close steelhead stocks the results are varied, ranging from one to six enzyme systems with statistically significant differences in isozyme gene frequencies (Table 7). Generally, the comparisons between stocks in the lower Columbia and between stocks in the Willamette had more statistically significant differences in isozyme gene frequencies than the comparisons between stocks from the upper Columbia or Snake Rivers. The reasons for this trend are not clear at this time.

Comparisons using hatchery steelhead stocks suggest that selection may play a role in determining isozyme gene frequencies. However, these results are preliminary and other factors such as founder effect and genetic drift cannot be excluded at this time. Comparisons of isozyme gene frequencies were made among two sets of hatchery stocks (Table 7). The first set included three unrelated stocks that were reared at the Cowlitz Hatchery (Skamania summer steelhead, Chambers Creek winter steelhead and Cowlitz native winter steelhead) and the second set included three stocks which have the same parentage but were reared at different locations. The parent stock is the Washougal Hatchery summer steelhead, also known as Skamania summer steelhead. The other two Skamania stocks in the comparisons are now being used at the Leaburg and South Santiam hatcheries. The pairwise comparisons of the three unrelated stocks from Cowlitz hatchery had only two or three statistically significant differences in isozyme gene frequencies which seems low considering that these stocks are of different races and from different areas. The comparisons between the three Skamania stocks had a high number of statistically significant differences in isozyme gene frequencies particularly between the Washougal Hatchery stock and the two Willamette River stocks. These results indicate that the two Willamette River stocks are quite different from the parent Washougal stock, possibly because of founder effects or selection.

Cluster Analyses

We used 48 stocks of chinook and 42 stocks of steelhead (See Tables 2 and 3 for locations of these stocks) for our cluster analyses with isozyme gene frequencies. The composition of the main clusters in the analysis of chinook and steelhead are summarized in Figures 3 and 4. The cluster analysis tended to group chinook stocks by both geographic areas and by race, but it is difficult to determine which is most important. For example, spring chinook tend to cluster geographically (lower Columbia, Idaho, Willamette and upper Columbia), However, in the lower Columbia (below Bonneville Dam) the spring chinook and fall chinook tend to cluster together while the upper Columbia spring chinook clustered separately from the upper Columbia fall and summer stocks. Another example of geographic clustering involves the summer chinook stocks. Summer chinook stocks from the state of Washington (Okanagan, Methow and Wells Dam) clustered with two upper Columbia fall chinook stocks (Priest Rapids and Hanford Reach) while the McCall hatchery summer chinook clustered with two Idaho based spring chinook stocks. Actually, this might be expected since the juvenile life history of the Washington State summer chinook is similar to that of fall chinook (migration to the ocean as age 0+ smolts) while the McCall hatchery summer chinook has a juvenile life history similar to that of spring chinook (migration to the ocean as age l+ smolts).

In general, it appears that both geographic and racial factors are important in determining the outcome of the cluster analyses. The results may have been affected by the wild fall and summer chinook stocks. These fish were too small when we collected them and thus several enzyme systems could not be resolved. We have resampled these stocks and will have more complete data for the final report.

The cluster analyses using isozyme gene frequencies for steelhead stocks also showed both geographical and racial tendencies in the clustering patterns (Figure 4). Native winter and summer steelhead tend to be geographically separated except in the lower Columbia (below The Dalles dam), To our knowledge there are no stream systems in the lower Columbia Basin where we could sample both summer and winter steelhead juveniles separately since the juveniles are well mixed when they are sampled at age l+ years old. We do have either summer or winter steelhead from numerous streams below The Dalles dam. These and other stocks tended to cluster into geographical clusters with the lower Columbia stocks clustering into winter and summer steelhead groups. However, these two lower Columbia clusters were very similar to each other (correlation =.99) and each cluster contained one stock that would normally be associated with the other lower Columbia River cluster. These results suggest that the lower Columbia summer and winter steelhead are quite similar electrophoretically which agrees with the findings of Chilcote et a1.(1980) on Kalama River steelhead. In that study they were unable to distinguish between winter and summer steelhead using isozyme gene frequencies. In our final report electrophoretic, morphometric and life history characters will be combined for the cluster analyses. This should provide more balanced results since it will be based on several different types of characters.

Heterozygosity

We calculated relative heterozygosity values for 48 stocks of chinook salmon and 42 stocks of steelhead trout. These heterozygosity values are relative since we did not include enzyme systems that were invariant for all stocks. We will include actual heterozygosity estimates in the final report. We divided the stocks into groups based on geographical area, race and origin of stock (hatchery or wild) and calculated the averages for each group (Table 8 and Figures 5 and 6).

Among the chinook stocks we found that the hatchery stocks had a higher relative heterozygosity than the wild stocks. Among the races, spring chinook had the lowest heterozygosity and the summer chinook had the highest with the fall chinook stocks intermediate. When the stocks were grouped by geographic area there was no clear trend except that hatchery stocks were higher in heterozygosity than were the wild stocks within each area. Heterozygosity levels of steelhead were similar between the hatchery and wild stocks and the winter steelhead had slightly higher levels of heterozygosity than the summer steelhead. Among the geographic regions there was a slight decrease in heterozygosity of steelhead in the upper parts of the Columbia River basin. In general, the differences in heterozygosity levels among the groups of steelhead appear to be too small to be of importance to management decisions.

Meristic Data

Analysis of Variance

Meristic counts have been completed for 37 stocks of steelhead and 41 stocks of chinook except for gill rakers and branchiostegal rays (Tables 9 and 10). The results of the analysis of variance indicates that there are statistically significant differences among the stocks for each of the characteristics but it is difficult to separate the environmental and genetic effects on meristic counts. The genetic basis for differences in meristic counts was documented for steelhead by Winter et al. (1980), Neave (1944), Smith (1969), and MacGregor and MacCrimmon (1977). Environmental influences probably play only a minor role in determining the nature of meristic characters evaluated. Studies by Seymour (1959) suggest that the effects of temperature on the number of vertebrae, dorsal rays and anal rays in chinook salmon is relatively small over a broad temperature range (45^{o} - 50^{o}F). Since most chinook and steelhead spawn at about the same temperature and the meristic characters are most sensitive to the effects of temperature only during the first month of incubation, the chances of encountering extreme temperatures that would greatly affect the meristic counts is fairly small. An exception to this rule would be hatcheries that use well or spring water for incubation. We will compile temperature data from hatcheries and, if possible, streams to determine if any of the incubation temperatures are extreme enough to greatly affect the meristic counts.

Cluster Analysis

We conducted cluster analyses of the meristic characters in Tables 9 and 10 for both steelhead and chinook stocks. The results of the analysis are summarized in Figures 7 and 8. The basic patterns of the cluster analysis based on meristic characters are similar to those of the cluster analyses based on isozyme gene frequencies, thus demonstrating the validity of using morphological characters for discriminating at the stock level. Fewer clusters were generated by the analysis of the meristic data because they are based on seven characters whereas the cluster analyes using electrophoretic characters are based on 18 enzyme systems for chinook and 21 enzyme systems for steelhead thereby increasing the chances of having a character that will discriminate between groups. The cluster analysis of chinook stocks exhibited both geographic and racial tendencies in that the fall and summer chinook clustered separately from the spring chinook and the spring chinook clustered into two groups, one east and one west of the Cascade Mountains. The cluster analysis of steelhead resulted in three basic clusters, all of which could be described primarily by geographic areas; the Willamette winter steelhead, lower Columbia winter and summer steelhead and upper basin summer steelhead. These results are similar to the cluster analysis obtained from the electrophoretic data of steelhead stocks. In both cases the lower Columbia winter and summer steelhead were very similar. Cluster analyses in the final report will be based on a combination of life history, morphometric, meristic and electrophoretic characters.

Influence of Condition on Morphormetry

Linear body measurements and truss-type characters in the caudal peduncle are less affected by condition factor and may be useful in our analysis for discriminating among stocks. We used three different size groups (small, medium, and large) to determine the effects of condition factor on morphometric measurements (Table 11). Several patterns were noted as to which types of morphometric characters are not affected by condition factor (Figures 9 and 10). In the truss-type measurements the unaffected morphometric characters were generally in either the measurements of the caudal peduncle, linear measurements around the posterior perimeter (behind the dorsal and pelvic fins) or some of the head dimensions. Most of the classical morphometric characters are linear and were unaffected by condition factor in at least one of the size groups. Those classical measurements affected by condition factor in all three size groups were head length, maxillary length, and body depth. We had not expected the head measurements to be affected since they are based on bony parts where little fat deposition takes place. In light of the needs of our study, it appears that the morphometric characters in the gut area of the fish are consistently affected by condition factor and willnotbe useful for our study. We are currently rearing Willamette Hatchery spring chinook to determine the suitability of the various morphometric characters for discriminating among stocks of chinook.

SUMMARY AND CONCLUSIONS

1. We have collected fish from 60 stocks of chinook salmon and 62 stocks of steelhead trout. Electrophoretic analyses were completed on 43 stocks of chinook salmon and 41 stocks of steelhead trout and meristic counts have been completed on 41 stocks of chinnok salmon and 37 stocks of steelhead.

2. As reported last year, the isozyme gene frequencies of most enzyme systems are fairly stable over time but some may be dynamic and should be used with caution in our final analysis.

3. Comparisons of the isozyme gene frequencies of adjacent stocks

of chinook suggest that the number of statistically significant differences in isozyme gene frequencies between stocks tends to increase as the geographic distance between the stocks increases. Results from the adjacent steelhead stocks were inconclusive and conclusions must await final analyses.

4. Cluster analyses on both steelhead and chinook stocks using either isozyme gene frequencies or meristic characters produced clusters of geographically close stocks and clusters of similar races.

5. Chinook heterozygosity values based on isozyme gene frequencies were highest in summer chinook and hatchery stocks and lowest in the spring chinook and wild stocks. Steelhead heterozygosity values were highest in winter stocks and lowest in the summer stocks while the heterozygosity values for hatchery and wild stocks were similar,

6. Significant differences exist among the stocks for all meristic characters for both steelhead and chinook.

7. Preliminary results from our feeding experiment indicate that, for steelhead, linear characters, truss-type characters in the caudal peduncle and some head measurements are less likely to be affected by condition factor and may be useful in our final analysis for discriminating among the stocks.

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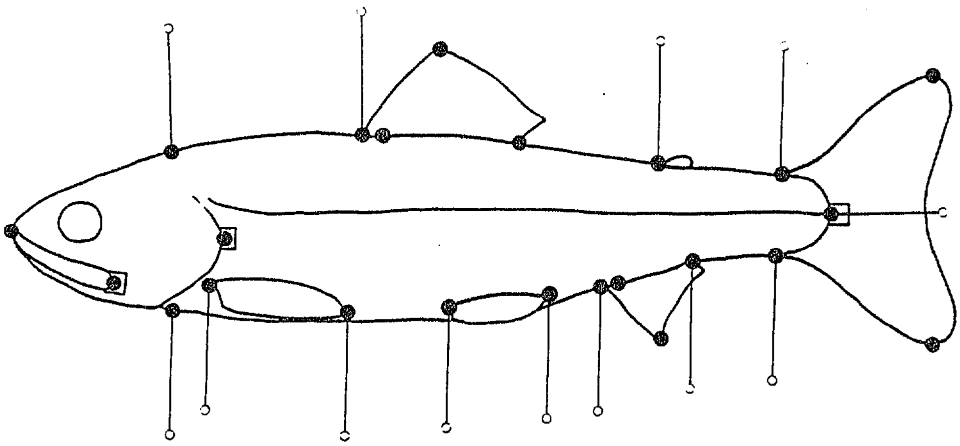

Figure 1. Landmark points on juvenile salmonid. The tip of the maxillary, the tip of the operculum and the last scale on the lateral line are highlighted with small strips of paper. Perimeter points that would otherwise be difficult to see on a photograph are highlighted with insect pins.

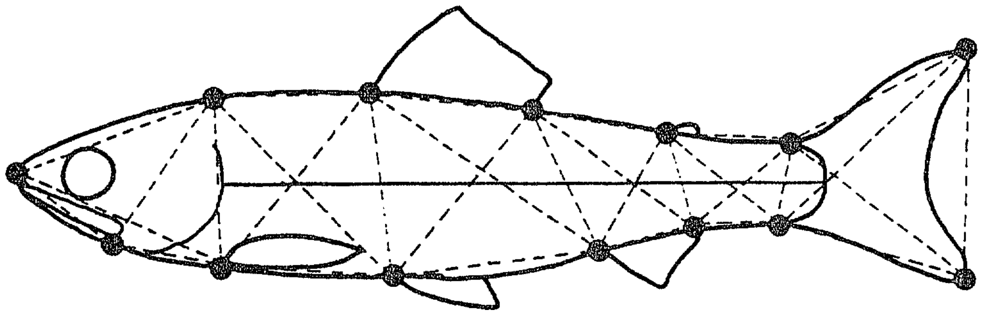

Figure 2. Juvenile salmonid showing truss-type measurements (dashed lines) (Winans 1984).

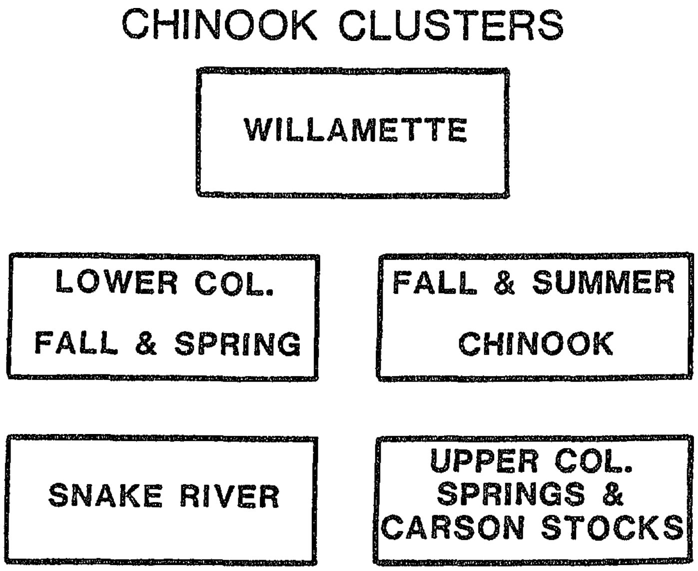

Figure 3. Summary of the cluster analysis based on isozyme gene frequencies of chinook salmon stocks.

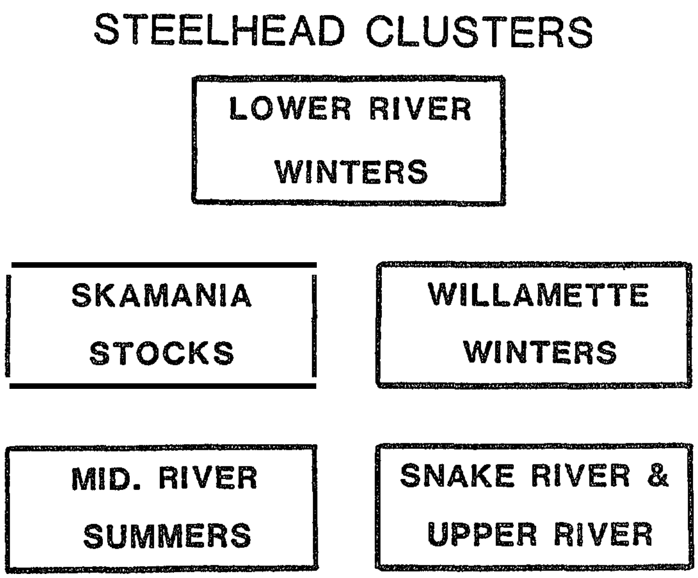

Figure 4. Summary of the cluster analysis based on isozyme gene frequencies of steelhead trout stocks.

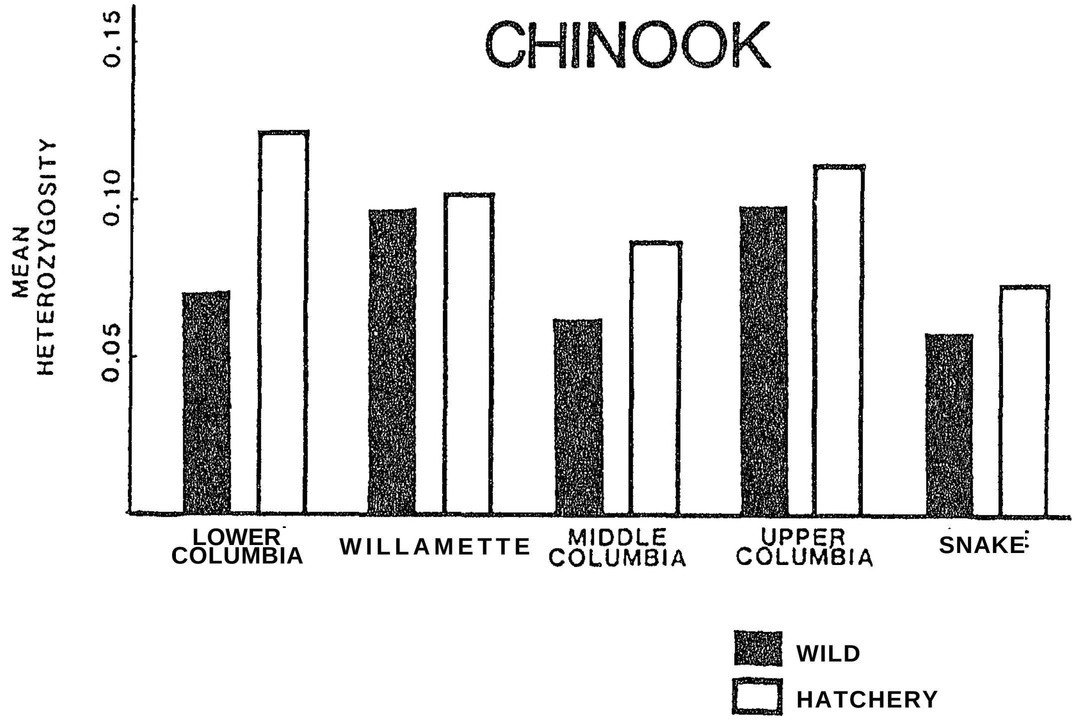

Figure 5. Relative heterozygosity values by geographic region for hatchery and wild chinook salmon stocks.

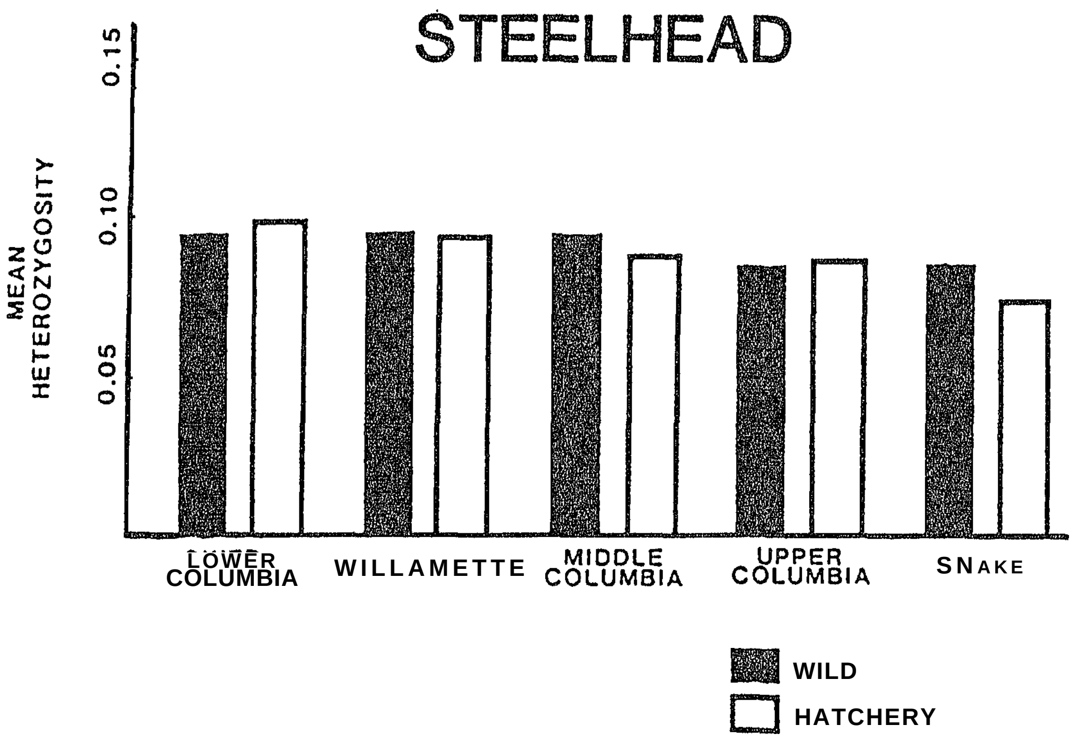

Figure 6. Relative heterozygosity values by geographic region for hatchery and wild steelhead trout stocks.

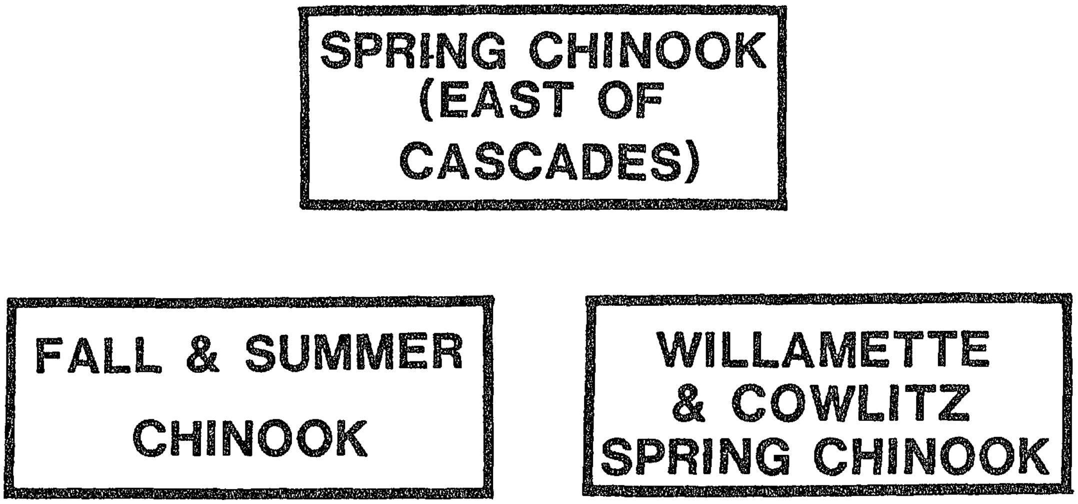

Figure 7. Summary of the cluster analysis based on meristic characters of chinook salmon stocks.

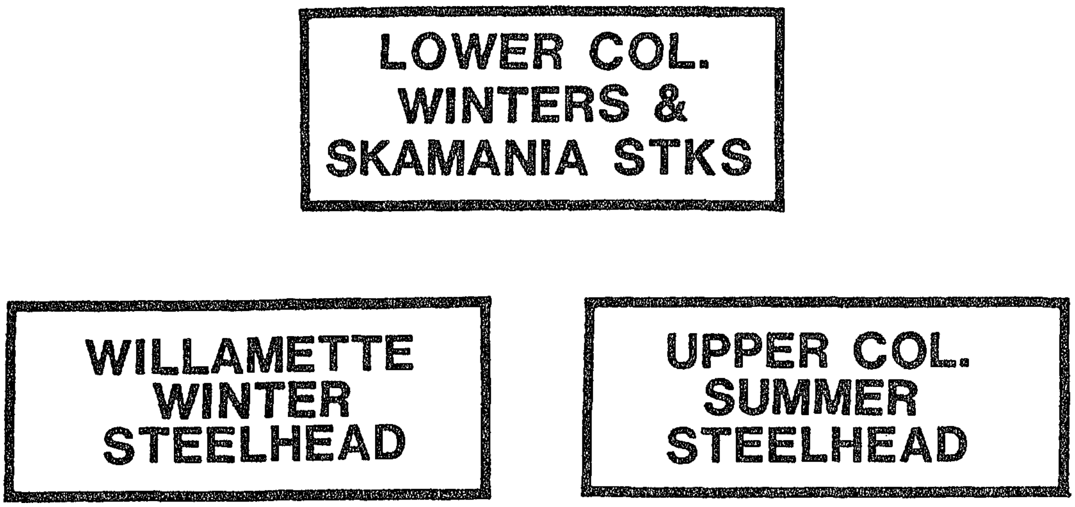

Figure 8. Summary of the cluster analysis based on meristic characters of steelhead trout stocks.

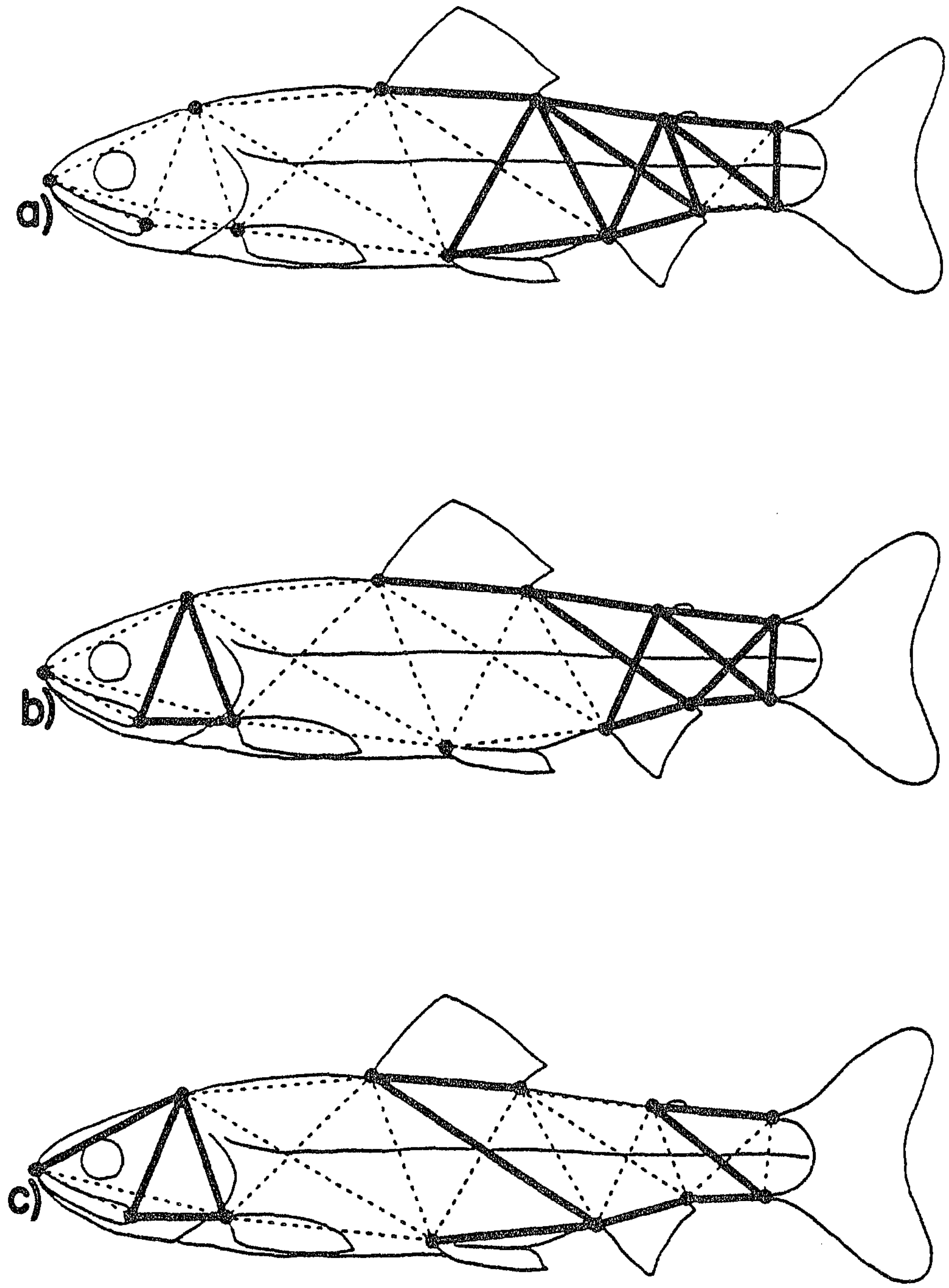

Figure 9. Truss-type morphometric characters of a) small (x = 6.4 cm), b) medium (x = 7.1 cm) and c) large (x = 10.2 cm) juvenile steelhead. Solid lines indicate morphometric characters not significantly affected by condition factor. Dashed lines indicate morphometric characters significantly affected by condition factor ($P < 0.05$).

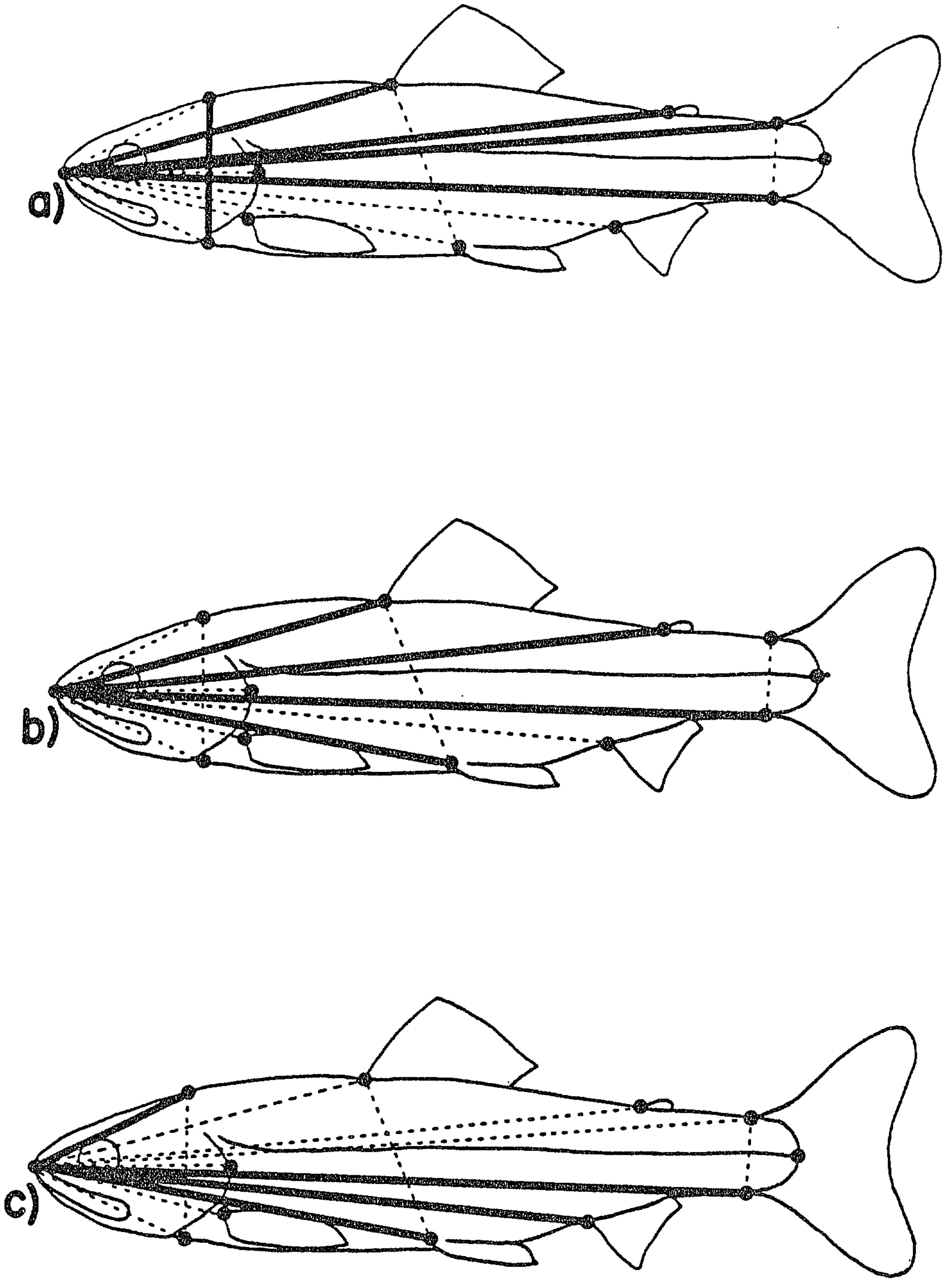

Figure 10. Classical morphometric characters of a) small)x = 6.4 cm), b) medium (x = 7.1 cm) and c) large (x = 10.2 cm) juvenile steelhead.Solidlinesindicatemorphometriccharactersnot significantly affected by condition factor. Dashed lines indicate morphometric characters significantly affected by condition factor ($P < 0.05$).

Table 1. Abbreviations for the enzyme systems that will be used to characterize stocks of Columbia River chinook salmon and steelhead trout.

ENZYME SYSTEM	ABBREVIATION
Aconitase	AC0
Adenosine deaminase	ADA
Alchohol dehydrogenase	ADH
Creatine kinase	CK
Glucose phosphate isomerase	GPI
Gluamate-oxalacetate transaminase	GOT
Glycerol-3-phosphate dehydrogenase	AGP
Isocitrate dehydrogenase	IDH
Lactate dehydrogenase	LDH
Malate dehydrogenase	MDH
Malic enzyme	ME
Mannose phosphate isomerase	MPI
Peptidase (Glycyl-L-leucine)	PEP-GL
Peptidase (Leucylglycylglycine)	PEP-LGG
Phosphoglucomutase	PGM
Phosphoglycerate kinase	PGK
Superoxide dismutase	SOD

Table 2. Isozyme gene frequencies and sample sizes (N) as determined by electrophoresis for chinook salmon stocks throughout the Columbia River Basin. Numbers at the top of each column are the relative mobilities for each allele present in the enzyme system. Minus signs indicate cathodal migration. An asterisk indicates that an allele was present at a frequency of less than 0.005. The code for race is F for fall chinook, S for spring chinook and SUM for summer chinook. Stocks marked by # indicate that those data were obtained from Milner et al. (1983). Numbers behind the stock names indicate years the fish were collected when more than one year is represented.

Table 2 (continued).

STOCK	RACE	ACONITASE				ADENOSINE DEAMINASE			ALCOHOL DEHYDROGENASE		
		N	100	86	116	N	100	83	N	-100	-52
COWLITZ HATCHERY #	F	91	.82	.17	.02	98	.99	.01	49	.97	.03
COWLITZ HATCHERY	S	92	.83	.16	.01	-			95	.96	.04
KALAMA HATCHERY	F	91	.91	.08	.01	-			88	.88	.12
KALAMA HATCHERY	S	96	.85	.14	.01	-			100	.96	.04
LEWIS HATCHERY	S	100	.98	.02		84	.92	.08	100	.98	.02
LEWIS HATCHERY	F	75	.77	.23		-			61	.94	.06
LEWIS RIVER	F	82	.82	.16	.01	-					
CLACKAMAS RIVER	S	79	.77	.20	.03	-			80	.99	.01
EAGLE CREEK HATCHERY	S	87	.76	.21	.03	100	1.00		100	.98	.02
MARION FORKS HATCHERY	S	97	.79	.19	.02	100	1.00		100	1.00	
SOUTH SANTIAM HATCHERY	S	98	.72	.27	.01	65	1.00		100	1.00	
THOMAS CREEK	S	95	.83	.16	.01	-			100	.98	.02
MCKENZIE HATCHERY	S	98	.79	.19	.02	50	1.00		100	1.00	
DEXTER HATCHERY	S	98	.75	.22	.03	100	1.00		100	1.00	
SANDY RIVER	F	56	.94	.03	.03	-			66	1.00	
BONNEVILLE HATCHERY	F	93	1.00			93	1.00		87	.87	.13
CARSON HATCHERY	S	100	.98	.02		-			100	1.00	
LITTLE WHITE SALMON HATCH.	S	100	.98	.02		-			100	1.00	
SPRING CREEK HATCHERY	F	100	1.00			100	1.00		82	.85	.15
KLICKITAT HATCHERY #	S	50	.93	.07		50	.98	.02	-		
HOOD RIVER	F	42	.88	.12		-			-		
DESCHUTES RIVER	F	85	.87	.06	.07	-			87	.93	.07
ROUND BUTTE HATCHERY	S	93	1.00			78	1.00		83	1.00	
WARM SPRINGS RIVER #	S	50	1.00			50	1.00		129	.98	.02
JOHN DAY RIVER	S	78	1.00			76	.99	.01	78	.99	.01
TUCANNON HATCHERY	F	97	.93	.06	.01	-			97	.91	.09
TUCANNON RIVER	S	93	.99	.01		-			93	1.00	
GRANDE RONDE RIVER 83	S	43	.98	.02		43	1.00		43	1.00	
GRANDE RONDE RIVER 84	S	26	.98	.02		-			36	.99	.01
WALLOWA-LOSTINE RIVER 83	S	47	1.00			47	1.00		47	1.00	
WALLOWA-LOSTINE RIVER 84	S	40	.99	.01		-			40	.98	.03
RED R. SF CLEARWATER #	S	40	1.00			40	.98	.03	40	1.00	
IMNAHA RIVER 83	S	87	.99	.01		87	1.00		87	.99	.01
IMNAHA RIVER 84	S	108	.99	.01		-			108	1.00	
RAPID RIVER HATCHERY #	S	50	.98	.02		50	.98	.02	50	1.00	
SALMON RIVER SAWTOOTH #	S	50	1.00			48	.97	.03	50	1.00	
McCALL HATCHERY #	SUM	50	1.00			50	.90	.10	50	1.00	
YAKIMA RIVER	S	50	.98	.02		42	.96	.04	50	1.00	
HANFORD REACH	F	53	.89	.11		-			100	1.00	
PRIEST RAPIDS HATCHERY	F	100	.84	.16		50	1.00		100	.99	.01
WENATCHEE RIVER	S	194	.99	.01		50	.95	.05	199	1.00	
WENATCHEE RIVER	SUM	40	.81	.19		-			50	1.00	
LEAVENWORTH HATCHERY	S	89	.99	.01		-			100	1.00	
ENTIAT RIVER	S	128	.98	.02		50	.97	.03	133	1.00	
WELLS DAM HATCHERY	SUM	98	.88	.12		98	1.00		100	1.00	
METHOW RIVER 83	S	53	.97	.03		-			-		
METHOW RIVER 84	S	50	.99	.01		50	.96	.04	50	1.00	
METHOW RIVER	SUM	85	.82	.18		-			-		
OKANAGAN RIVER	SUM	100	.78	.22		-			90	.97	.03

Table 2 (continued).

STOCK	RACE	GLUCOSE PHOSPHATE ISOMERASE-2			GLUCOSE PHOSPHATE ISOMERASE 1-3H			GLUCOSE PHOSPHATE ISOMERASE-3		
		N	100	60	N	STANDARD	VARIANT	N	100	90
COWLITZ HATCHERY #	F	99	1.00		-			99	1.00	
COWLITZ HATCHERY	S	100	1.00		100	.90	.10	100	1.00	
KALAMA HATCHERY	F	100	1.00		100	1.00		100	1.00	
KALAMA HATCHERY	S	100	1.00		100	.86	.14	100	1.00	
LEWIS HATCHERY	S	100	1.00		100	1.00		100	1.00	
LEWIS HATCHERY	F	96	.90	.10	96	1.00		100	1.00	
LEWIS RIVER	F	100	1.00		100	1.00		100	1.00	
CLACKAMAS RIVER	S	80	1.00		80	1.00		80	1.00	
EAGLE CREEK HATCHERY	S	100	1.00		100	1.00		100	1.00	
MARION FORKS HATCHERY	S	100	1.00		100	1.00		100	1.00	
SOUTH SANTIAM HATCHERY	S	100	1.00		100	1.00		100	1.00	
THOMAS CREEK	S	100	1.00		100	.80	.20	100	1.00	
MCKENZIE HATCHERY	S	95	1.00		95	.90	.10	95	1.00	
DEXTER HATCHERY	S	100	1.00		100	.83	.17	100	1.00	
SANDY RIVER	F	66	1.00		60	1.00		66	1.00	
BONNEVILLE HATCHERY	F	93	1.00		93	1.00		93	1.00	
CARSON HATCHERY	S	100	1.00		100	1.00		100	1.00	
LITTLE WHITE SALMON HATCH.	S	50	1.00		50	1.00		50	1.00	
SPRING CREEK HATCHERY	F	100	1.00		100	1.00		100	1.00	
KLICKITAT HATCHERY #	S	50	1.00		-			50	1.00	
HOOD RIVER	F	47	.99	.01	47	1.00		47	.99	.01
DESCHUTES RIVER	F	91	1.00		91	1.00		91	1.00	
ROUND BUTTE HATCHERY	S	100	1.00		100	1.00		100	1.00	
WARM SPRINGS RIVER #	S	49	1.00		-			49	1.00	
JOHN DAY RIVER	S	79	1.00		79	1.00		79	1.00	
TUCANNON HATCHERY	F	100	.99	.01	100	1.00		100	1.00	
TUCANNON RIVER	S	100	.86	.14	100	1.00		100	1.00	
GRANDE RONDE RIVER 83	S	43	1.00		43	1.00		43	1.00	
GRANDE RONDE RIVER 84	S	36	1.00		36	1.00		36	1.00	
WALLOWA-LOSTINE RIVER 83	S	47	.90	.10	47	1.00		47	1.00	
WALLOWA-LOSTINE RIVER 84	S	40	1.00		40	1.00		40	1.00	
RED R. SF CLEARWATER #	S	40	1.00		-			40	1.00	
IMNAHA RIVER 83	S	87	1.00		87	1.00		87	1.00	
IMNAHA RIVER 84	S	108	1.00		100	1.00		100	1.00	
RAPID RIVER HATCHERY #	S	50	1.00		-			50	1.00	
SALMON RIVER SAWTOOTH #	S	50	1.00		-			50	1.00	
McCALL HATCHERY #	SUM	50	1.00		-			50	1.00	
YAKIMA RIVER	S	42	1.00		30	1.00		48	1.00	
HANFORD REACH	F	96	1.00		96	.80	.20	96	1.00	
PRIEST RAPIDS HATCHERY	F	91	1.00		91	.90	.10	91	1.00	
WENATCHEE RIVER	S	194	1.00		194	1.00		194	1.00	
WENATCHEE RIVER	SUM	50	1.00		50	1.00		50	1.00	
LEAVENWORTH HATCHERY	S	95	1.00		95	1.00		95	1.00	
ENTIAT RIVER	S	133	1.00		133	1.00		133	1.00	
WELLS DAM HATCHERY	SUM	97	1.00		97	.83	.17	97	1.00	
METHOW RIVER 83	S	53	1.00		53	1.00		53	1.00	
METHOW RIVER 84	S	50	1.00		40	1.00		50	1.00	
METHOW RIVER	SUM	88	1.00		88	.89	.11	88	1.00	
OKANAGAN RIVER	SUM	100	.90	.10	100	.83	.17	100	1.00	

Table 2 (continued).

STOCK	RACE	GLUTAMATE OXALACETATE TRANSAMINASE-3			ISOCITRATE DEHYDROGENASE				LACTATE DEHYDROGENASE-4		
		N	100	90	N	100	74	127	N	100	120
COWLITZ HATCHERY #	F	68	1.00		97	.97	.02	.01	99	1.00	
COWLITZ HATCHERY	S	100	1.00		100	.97	.03		100	1.00	
KALAMA HATCHERY	F	100	1.00		73	.98	.01	.01	100	1.00	
KALAMA HATCHERY	S	100	1.00		88	.93	.07		100	1.00	
LEWIS HATCHERY	S	68	1.00		95	.87	.13		100	1.00	
LEWIS HATCHERY	F	-			87	.96	.01	.03	98	1.00	
LEWIS RIVER	F	100	1.00		99	.97	.01	.02	100	1.00	
CLACKAMAS RIVER	S	80	1.00		76	.95	.01	.04	80	1.00	
EAGLE CREEK HATCHERY	S	90	1.00		100	1.00			100	1.00	
MARION FORKS HATCHERY	S	100	1.00		100	1.00			100	1.00	
SOUTH SANTIAM HATCHERY	S	90	1.00		100	1.00			100	1.00	
THOMAS CREEK	S	100	1.00		89	.88	.11	.01	100	1.00	
MCKENZIE HATCHERY	S	100	1.00		70	.98	.01	*	100	1.00	
DEXTER HATCHERY	S	100	1.00		100	1.00			85	1.00	
SANDY RIVER	F	60	1.00		56	.96	.02	.01	66	1.00	
BONNEVILLE HATCHERY	F	93	1.00		-				93	1.00	
CARSON HATCHERY	S	100	1.00		87	.97	.03		100	.98	.02
LITTLE WHITE SALMON HATCH.	S	100	1.00		-				100	.98	.02
SPRING CREEK HATCHERY	F	100	1.00		100	1.00			100	1.00	
KLICKITAT HATCHERY #	S	49	1.00		50	.90	.03	.07	50	1.00	
HOOD RIVER	F	-			41	.99	.01		47	1.00	
DESCHUTES RIVER	F	96	1.00		98	.98	.01	*	100	1.00	
ROUND BUTTE HATCHERY	S	50	1.00		82	.95	.05	*	93	1.00	
WARM SPRINGS RIVER #	S	43	1.00		50	.83	.17		50	1.00	
JOHN DAY RIVER	S	75	1.00		70	.87	.13		95	1.00	
TUCANNON HATCHERY	F	100	.98	.02	88	.99	.01		100	1.00	
TUCANNON RIVER	S	100	1.00		92	.95	.05		100	.99	.01
GRANDE RONDE RIVER 83	S	43	1.00		42	.92	.08		43	1.00	
GRANDE RONDE RIVER 84	S	8	1.00		34	.87	.13		36	1.00	
WALLOWA-LOSTINE RIVER 83	S	25	1.00		46	.86	.11	.03	47	1.00	
WALLOWA-LOSTINE RIVER 84	S	34	1.00		35	.84	.15	.01	40	1.00	
RED R. SF CLEARWATER #	S	40	1.00		80	.94	.06		40	.95	.05
IMNAHA RIVER 83	S	87	1.00		84	.91	.09		87	1.00	
IMNAHA RIVER 84	S	100	1.00		89	.87	.13		108	1.00	
RAPID RIVER HATCHERY #	S	50	1.00		50	.97	.04		50	.98	.02
SALMON RIVER SAWTOOTH #	S	50	1.00		50	.92	.08		50	.98	.02
McCALL HATCHERY #	SUM	50	1.00		50	.87	.13		50	1.00	
YAKIMA RIVER	S	44	1.00		44	.86	.14		50	1.00	
HANFORD REACH	F	100	1.00		60	.92	.01	.07	100	1.00	
PRIEST RAPIDS HATCHERY	F	-			65	.97	.02		92	1.00	
WENATCHEE RIVER	S	180	1.00		160	.86	.14		199	.99	.01
WENATCHEE RIVER	SUM	-			44	.98	.01	.01	50	1.00	
LEAVENWORTH HATCHERY	S	-			96	.90	*	.10	100	.97	.03
ENTIAT RIVER	S	123	1.00		105	.81	.19		132	.98	.02
WELLS DAM HATCHERY	SUM	-			-				98	1.00	
METHOW RIVER 83	S	50	1.00		39	.89	.02	.09	43	1.00	
METHOW RIVER 84	S	43	1.00		37	.81	.19		50	.99	.01
METHOW RIVER	SUM	20	1.00		71	.95	.04	*			
OKANAGAN RIVER	SUM	-			84	.93	.06	.01	96	1.00	

Table 2 (continued).

STOCK	RACE	LACTATE DEHYDROGENASE-5			MALATE DEHYDROGENASE-1&2				MALATE DEHYDROGENASE-3&4			
		N	100	90	N	100	140	27	N	100	121	70
COWLITZ HATCHERY *	F	96	.99	.01	99	1.00			99	1.00		
COWLITZ HATCHERY	S	100	.99	.01	100	1.00			100	.99	.01	
KALAMA HATCHERY	F	100	1.00		100	1.00			100	.98	.02	
KALAMA HATCHERY	S	100	.99	.01	100	1.00			100	.99	.01	
LEWIS HATCHERY	S	80	1.00		50	1.00			100	.98	.02	
LEWIS HATCHERY	F	98	1.00		100	1.00			90	.99	.01	
LEWIS RIVER	F	100	1.00		100	1.00			94	.98	.02	
CLACKAMAS RIVER	S	87	1.00		80	1.00			80	.97	.03	
EAGLE CREEK HATCHERY	S	87	1.00		100	1.00			100	.95	.05	
MARION FORKS HATCHERY	S	100	1.00		100	1.00			98	.92	.08	
SOUTH SANTIAM HATCHERY	S	100	1.00		94	1.00			100	.95	.05	
THOMAS CREEK	S	100	1.00		100	1.00			99	.92	.08	
MCKENZIE HATCHERY	S	100	.99	.01	100	1.00			99	.93	.07	
DEXTER HATCHERY	S	85	1.00		100	1.00			100	.93	.07	
SANDY RIVER	F	66	1.00		66	1.00			66	1.00		
BONNEVILLE HATCHERY	F	83	1.00		93	1.00			88	.92	.08	
CARSON HATCHERY	S	100	1.00		100	1.00			100	1.00	*	
LITTLE WHITE SALMON HATCH.	S	92	1.00		100	1.00			100	.98	.02	
SPRING CREEK HATCHERY	F	100	1.00		100	1.00			100	.92	.08	
KLICKITAT HATCHERY *	S	50	1.00		50	1.00			50	.97	.03	
HOOD RIVER	F	47	1.00		47	1.00			47	.99		.01
DESCHUTES RIVER	F	100	1.00		100	1.00			100	.97	.01	.02
ROUND BUTTE HATCHERY	S	93	1.00		93	1.00			100	.99	.01	
WARM SPRINGS RIVER *	S	46	1.00		50	.99	.01		49	1.00		
JOHN DAY RIVER	S	96	1.00		100	.99	.01		100	1.00		
TUCANNON HATCHERY	F	100	.99	.01	100	1.00			100	.95	.01	.04
TUCANNON RIVER	S	100	1.00		100	1.00			100	1.00		
GRANDE RONDE RIVER 83	S	43	1.00		43	1.00			43	1.00		
GRANDE RONDE RIVER 84	S	-			36	1.00			36	.98	.02	
WALLOWA-LOSTINE RIVER 83	S	47	1.00		47	1.00			45	.95	.05	
WALLOWA-LOSTINE RIVER 84	S	40	1.00		40	1.00			40	1.00		
RED R. SF CLEARWATER *	S	40	1.00		80	1.00			78	.99	.01	
IMNAHA RIVER 83	S	87	1.00		87	1.00			87	.99	.01	
IMNAHA RIVER 84	S	107	1.00		108	1.00			108	.98	.02	
RAPID RIVER HATCHERY *	S	50	1.00		50	1.00			49	1.00		
SALMON RIVER SAWTOOTH *	S	48	1.00		50	1.00			49	1.00		
McCALL HATCHERY *	SUM	50	.97	.03	50	1.00			50	.99	.01	
YAKIMA RIVER	S	50	1.00		50	1.00			50	1.00		
HANFORD REACH	F	100	.97	.03	100	1.00			98	.97	.01	.01
PRIEST RAPIDS HATCHERY	F	100	.98	.02	100	1.00			100	.98	.01	.02
WENATCHEE RIVER	S	181	1.00		195	1.00	*		95	.97	.03	
WENATCHEE RIVER	SUM	45	.99	.01	50	1.00			48	.97	.01	.02
LEAVENWORTH HATCHERY	S	100	1.00		100	1.00			100	.99	.01	
ENTIAT RIVER	S	121	1.00		132	1.00	*		31	.99	.01	
WELLS DAM HATCHERY	SUM	90	.99	.01	98	1.00			98	.98	.01	.01
METHOW RIVER 83	S	50	.99	.01	43	1.00			45	.97	.03	
METHOW RIVER 84	S	49	1.00		50	.99	*	*	50	.97	.03	
METHOW RIVER	SUM	80	.99	.01	88	1.00			87	.97	.02	.01
OKANAGAN RIVER	SUM	100	.93	.07	100	1.00			95	.97	.02	.01

Table 2 (continued).

STOCK	RACE	MANNOSE PHOSPHATE ISOMERASE					PEPTIDASE (GLYCYL-L-LEUCINE-1)			PEPTIDASE (LEUCYLGLYCYLGLYCINE)			
		N	100	109	95	113	N	100	90	N	100	130	45
COWLITZ HATCHERY #	F	99	.49	.48	.03		99	.92	.08	99	.94	.06	
COWLITZ HATCHERY	S	99	.47	.50	.03		100	.99	.01	100	.91	.09	
KALAMA HATCHERY	F	56	.63	.37			100	1.00		100	.70	.30	
KALAMA HATCHERY	S	100	.57	.43			100	1.00		100	.95	.05	
LEWIS HATCHERY	S	72	.85	.15			100	.98	.02	95	.95	.05	
LEWIS HATCHERY	F	85	.53	.45	.02		98	.95	.05	95	.93	.07	
LEWIS RIVER	F	100	.49	.48	.03		100	.84	.16	100	.96	.04	
CLACKAMAS RIVER	S	79	.47	.53			80	1.00		80	.96	.04	
EAGLE CREEK HATCHERY	S	84	.61	.38		.01	100	1.00		99	.92	.08	
MARION FORKS HATCHERY	S	95	.46	.54			100	1.00		98	.91	.09	
SOUTH SANTIAM HATCHERY	S	97	.50	.50			100	1.00		95	.65	.35	
THOMAS CREEK	S	95	.42	.58			100	1.00		100	.87	.13	
MCKENZIE HATCHERY	S	97	.47	.52	.01		100	1.00		99	.87	.13	
DEXTER HATCHERY	S	88	.53	.47			100	1.00		100	.83	.17	
SANDY RIVER	F	64	.55	.45	.01		66	1.00		66	.95	.05	
BONNEVILLE HATCHERY	F	87	.59	.40	.01		93	1.00		92	.83	.17	
CARSON HATCHERY	S	99	.90	.10			100	1.00		100	.91	.09	
LITTLE WHITE SALMON HATCH.	S	96	.82	.18			100	.99	.01	99	.94	.06	
SPRING CREEK HATCHERY	F	96	.54	.43	.03		100	.94	.06	96	.83	.17	
KLICKITAT HATCHERY #	S	50	.73	.26	.01		50	.99	.01	50	.95	.05	
HOOD RIVER	F	-					47	1.00		47	.93	.07	
DESCHUTES RIVER	F	99	.79	.21			100	.97	.03	99	.97	.03	
ROUND BUTTE HATCHERY	S	93	.84	.16			93	1.00		93	.98	.02	
WARM SPRINGS RIVER #	S	50	.84	.16			50	.97	.03	48	.97	.03	
JOHN DAY RIVER	S	93	.91	.09			100	1.00		85	.99	.01	
TUCANNON HATCHERY	F	100	.82	.18			100	.99	.01	86	.87	.13	
TUCANNON RIVER	S	100	.90	.10			100	1.00		90	.99	.01	
GRANDE RONDE RIVER 83	S	36	.92	.08			43	1.00		43	.98		.02
GRANDE RONDE RIVER 84	S	36	.90	.10			36	.99	.01	35	.96	.04	
WALLOWA-LOSTINE RIVER 83	S	45	.76	.24			47	1.00		43	.96	.04	
WALLOWA-LOSTINE RIVER 84	S	39	.74	.26			35	1.00		40	.99	.01	
RED R. SF CLEARWATER #	S	40	.95	.05			40	1.00		36	.94	.06	
IMNAHA RIVER 83	S	86	.80	.20			87	.99	.01	87	.99	.01	.01
IMNAHA RIVER 84	S	99	.82	.18			108	1.00		108	1.00		
RAPID RIVER HATCHERY #	S	50	.95	.05			50	1.00		50	.90	.10	
SALMON RIVER SAWTOOTH #	S	50	.89	.11			50	.99	.01	50	.86	.14	
McCALL HATCHERY #	SUM	50	.96	.04			50	1.00		50	.93	.07	
YAKIMA RIVER	S	50	.86	.14			50	.98	.02	47	.95	.05	
HANFORD REACH	F	99	.72	.27	.01		100	1.00		100	.77	.23	
PRIEST RAPIDS HATCHERY	F	88	.74	.26			100	1.00		94	.68	.32	
WENATCHEE RIVER	S	165	.90	.10			191	.99	.01	181	.91	.09	
WENATCHEE RIVER	SUM	34	.66	.34			50	1.00		-			
LEAVENWORTH HATCHERY	S	100	.90	.10			100	.99	.01	100	.87	.13	
ENTIAT RIVER	S	132	.90	.10			132	.99	.01	118	.94	.06	
WELLS DAM HATCHERY	SUM	76	.71	.29			98	1.00		98	.66	.34	
METHOW RIVER 83	S	36	.85	.15			53	1.00		53	.90	.10	
METHOW RIVER 84	S	50	.97	.03			50	1.00		50	.97	.03	
METHOW RIVER	SUM	-					88	1.00		86	.73	.27	
OKANAGAN RIVER	SUM	92	.74	.26			100	1.00		96	.68	.32	

Table 2 (continued).

STOCK	RACE	PHOSPHOGLUCOMUTASE			PHOSPHOGLYCERATE KINASE-2				SUPEROXIDE DISMUTASE			
		N	-100	-60	N	100	90	64	N	-100	-260	1250
COWLITZ HATCHERY #	F	99	.99	.01	50	.79	.21		98	.65	.35	
COWLITZ HATCHERY	S	100	1.00		-				99	.57	.43	
KALAMA HATCHERY	F	100	1.00		52	.88	.12		80	.58	.42	
KALAMA HATCHERY	S	100	1.00		-				100	.66	.34	
LEWIS HATCHERY	S	100	1.00		100	.14	.86		50	.56	.44	
LEWIS HATCHERY	F	100	1.00		-				47	.48	.52	
LEWIS RIVER	F	100	1.00		-				-			
CLACKAMAS RIVER	S	80	1.00		-				28	.84	.16	
EAGLE CREEK HATCHERY	S	100	1.00		95	.06	.94		98	.67	.33	
MARION FORKS HATCHERY	S	50	1.00		77	.98	.02		100	.80	.20	
SOUTH SANTIAM HATCHERY	S	100	1.00		99	.94	.06		99	.84	.16	
THOMAS CREEK	S	100	1.00		100	.93	.07		100	.81	.19	
MCKENZIE HATCHERY	S	100	1.00		84	.88	.12		100	.81	.19	
DEXTER HATCHERY	S	100	1.00		94	.90	.10		100	.92	.08	
SANDY RIVER	F	66	1.00		-				-			
BONNEVILLE HATCHERY	F	93	1.00		93	1.00			83	.52	.48	
CARSON HATCHERY	S	100	1.00		100	.02	.98		97	.81	.19	
LITTLE WHITE SALMON HATCH.	S	100	1.00		72	.12	.88		100	.78	.22	
SPRING CREEK HATCHERY	F	100	1.00		91	.91	.09		80	.58	.42	
KLICKITAT HATCHERY #	S	50	1.00		50	.57	.43		50	.69	.31	
HOOD RIVER	F	47	1.00		-				-			
DESCHUTES RIVER	F	100	1.00		-				76	.70	.30	
ROUND BUTTE HATCHERY	S	93	1.00		93	.45	.55		81	.56	.44	
WARM SPRINGS RIVER #	S	50	1.00		50	.32	.68		50	.54	.46	
JOHN DAY RIVER	S	95	1.00		39	.06	.94		81	.73	.27	
TUCANNON HATCHERY	F	100	1.00		51	.67	.33		88	.64	.36	
TUCANNON RIVER	S	93	1.00		77	.06	.94		54	.78	.22	
GRANDE RONDE RIVER 83	S	43	1.00		37	.23	.77		43	.79	.21	
GRANDE RONDE RIVER 84	S	36	1.00		-				36	.85	.15	
WALLOWA-LOSTINE RIVER 83	S	47	1.00		45	.07	.92	.01	47	.79	.21	
WALLOWA-LOSTINE RIVER 84	S	40	1.00		90		1.00		40	.86	.14	
RED R. SF CLEARWATER #	S	40	1.00		40	.15	.85		40	.95	.05	
IMNAHA RIVER 83	S	87	1.00		78	.15	.85		87	.89	.11	
IMNAHA RIVER 84	S	108	1.00		90		1.00		87	.87	.13	
RAPID RIVER HATCHERY #	S	50	1.00		50	.15	.85		50	.96	.04	
SALMON RIVER SAWTOOTH #	S	50	1.00		50	.09	.91		48	.95	.05	
McCALL HATCHERY #	SUM	50	1.00		50	.08	.92		50	.98	.02	
YAKIMA RIVER	S	50	1.00		30	.17	.83		50	.76	.24	
HANFORD REACH	F	100	1.00		39	.74	.26		-			
PRIEST RAPIDS HATCHERY	F	100	1.00		-				92	.50	.50	
WENATCHEE RIVER	S	184	1.00		76	.09	.91		170	.82	.18	
WENATCHEE RIVER	SUM	50	1.00		-				-			
LEAVENWORTH HATCHERY	S	100	1.00		76	.03	.97		100	.84	.16	
ENTIAT RIVER	S	128	1.00		35	.03	.97		130	.76	.24	
WELLS DAM HATCHERY	SUM	98	1.00		74	.64	.36		97	.58	.42	
METHOW RIVER 83	S	53	1.00		-				36	.67	.33	
METHOW RIVER 84	S	50	1.00		35	.03	.97		50	.77	.23	
METHOW RIVER	SUM	88	.99	.01					76	.49	.51	
OKANAGAN RIVER	SUM	100	1.00		49	.70	.30		-			

Table 3. Isozyme gene frequencies and sample sizes (N) as determined by electrophoresis for steelhead trout stocks throughout the Columbia River Basin. Numbers at the top of each column are the relative mobilities for each allele present in the enzyme system. Minus signs indicate cathodal migration. An asterisk indicates that an allele was present at a frequency of less than 0.005. The code for race is S for summer steelhead and W for winter steelhead. The Middle Fork Salmon River data came from Wishard and Seeb (1983). Numbers behind the stock names indicate years the fish were collected when more than one year is represented.

Table 3 (continued).

STOCK	RACE	ACONITASE				ALCOHOL DEHYDROGENASE			ALPHA-GLYCEROPHOSPATE DEHYDROGENASE		
		N	100	83	66	N	-100	-76	N	100	140
BIG CREEK HATCHERY	W	98	.94	.06		100	1.00		100	.99	.01
GRAYS RIVER	W	87	.81	.15	.04	100	1.00		100	.99	.01
ELOCHOMAN HATCHERY	W	49	.72	.18	.09	100	1.00		97	.97	.03
COWLITZ HATCHERY NATIVE	W	68	.91	.09		85	1.00		83	.91	.09
COWLITZ HATCHERY CHAMBERS	W	97	.86	.10	.04	100	1.00		92	.97	.03
COWLITZ HATCHERY SKAMANIA	S	87	.92	.07	.01	90	1.00		75	.95	.05
EAGLE CREEK HATCHERY	W	100	.93	.04	.04	100	1.00		90	.97	.03
" " "	S	80	.99	.01		100	1.00		51	.97	.03
MARION FORKS HATCHERY	W	100	.99	.01		100	1.00		100	.85	.15
THOMAS CREEK 83	W	50	.98		.02	90	1.00		-		
THOMAS CREEK 84	W	55	.98		.02	55	1.00		40	.93	.07
WILEY CREEK	W	100	.96	.02	.02	100	1.00		100	.74	.26
SOUTH SANTIAM HATCHERY	S	97	.98	.02		97	1.00		96	.93	.07
CALAPOOYA RIVER 83	W	-				80	1.00		-		
CALAPOOYA RIVER 84	W	45	1.00			45	1.00		44	.85	.15
LEABURG HATCHERY	S	100	.99	.01		100	1.00		97	.92	.08
SANDY RIVER	W	95	.87	.12	.01	100	1.00		100	.96	.04
WASHOUGAL HATCHERY	S	100	.95	.05		100	1.00		95	.77	.23
HAMILTON CREEK	W	52	.89	.12		53	1.00		53	.88	.12
WIND RIVER	S	38	.95	.05		50	1.00		35	.96	.04
KLICKITAT RIVER	S	95	.89	.08	.02	100	1.00		85	.90	.10
FIFTEENMILE CREEK	W	81	.85	.10	.05	82	1.00		-		
ROUND BUTTE HATCHERY	S	92	.73	.27		100	.99	.01	100	.99	.01
JOHN DAY RIVER	S	84	.84	.16		100	1.00		100	1.00	
UMATILLA RIVER	S	87	.72	.28		100	.99	.01	100	1.00	
UMATILLA HATCHERY	S	98	.90	.03	.07	100	.97	.03	100	.99	.01
TUCANNON RIVER	S	107	.85	.12	.03	113	1.00		113	1.00	
GRANDE RONDE RIVER 83	S	43	.80	.19	.01	50	1.00		50	.98	.02
GRANDE RONDE RIVER 84	S	96	.85	.14	.01	110	1.00		100	.96	.04
WALLOWA-LOSTINE 83	S	71	.86	.14		73	.99	.01	-		
WALLOWA-LOSTINE 84	S	58	.87	.13		100	1.00		100	1.00	
WALLOWA HATCHERY	S	100	.78	.15	.08	100	1.00		98	1.00	
IMNAHA RIVER 83	S	89	.78	.21	.01	96	1.00		-		
IMNAHA RIVER 84	S	57	.83	.16	.01	58	1.00		55	1.00	
IMNAHA HATCHERY	S	100	.79	.21	*	100	1.00		100	1.00	
MIDDLE FORK SALMON RIVER #	S	158	.73	.09	.18	277	1.00		158	1.00	
SOUTH FORK SALMON RIVER	S	52	.62	.32	.07	61	1.00		61	1.00	
YAKIMA RIVER 83	S	42	.86	.14		48	1.00		43	.98	.02
YAKIMA RIVER 84	S	45	.69	.31		49	1.00		49	1.00	
ENTIAT RIVER	S	48	.77	.18	.05	50	1.00		50	1.00	
WELLS HATCHERY	S	79	.76	.24		81	1.00		81	1.00	
METHOW RIVER	S	54	.72	.27	.01	58	1.00		58	1.00	

Table 3 (continued).

STOCK	RACE	CREATINE KINASE			GLUCOSE PHOSPHATE ISOMERASE 1				GLUCOSE PHOSPHATE ISOMERASE 2		
		N	100	70	N	100	130	25	N	100	120
BIG CREEK HATCHERY	W	100	1.00		100	1.00			100	1.00	
GRAYS RIVER	W	100	1.00		100	1.00			100	1.00	
ELOCHOMAN HATCHERY	W	100	1.00		100	1.00			100	1.00	
COWLITZ HATCHERY NATIVE	W	99	1.00		91	1.00			91	1.00	
COWLITZ HATCHERY CHAMBERS	W	83	1.00		95	1.00			95	1.00	
COWLITZ HATCHERY SKAMANIA	S	80	1.00		90	1.00			90	1.00	
EAGLE CREEK HATCHERY	W	100	1.00		98	1.00			98	1.00	
" " "	S	100	1.00		80	1.00			80	1.00	
MARION FORKS HATCHERY	W	100	1.00		100	.86	.14		100	1.00	
THOMAS CREEK 83	W	-			100	1.00			100	1.00	
THOMAS CREEK 84	W	55	1.00		55	1.00			55	1.00	
WILEY CREEK	W	100	1.00		100	1.00			100	1.00	
SOUTH SANTIAM HATCHERY	S	97	1.00		97	1.00			97	1.00	
CALAPOOYA RIVER 83	W	-			100	1.00			100	1.00	
CALAPOOYA RIVER 84	W	47	1.00		47	1.00			47	1.00	
LEABURG HATCHERY	S	100	1.00		95	1.00			95	1.00	
SANDY RIVER	W	100	1.00		100	1.00			100	1.00	
WASHOUGAL HATCHERY	S	100	1.00		95	1.00			95	1.00	
HAMILTON CREEK	W	53	1.00		53	.99		.01	53	1.00	
WIND RIVER	S	50	1.00		50	.91		.09	50	1.00	
KLICKITAT RIVER	S	100	1.00		100	1.00			100	1.00	
FIFTEENMILE CREEK	W	82	1.00		82	1.00			82	.96	.04
ROUND BUTTE HATCHERY	S	93	.96	.04	100	1.00			100	1.00	
JOHN DAY RIVER	S	100	1.00	*	100	1.00			100	1.00	
UMATILLA RIVER	S	100	1.00		100	1.00			100	1.00	
UMATILLA HATCHERY	S	100	1.00		100	1.00			100	1.00	
TUCANNON RIVER	S	113	.99	.01	113	1.00			113	1.00	
GRANDE RONDE RIVER 83	S	50	1.00		50	1.00			50	1.00	
GRANDE RONDE RIVER 84	S	110	1.00		110	1.00			110	1.00	
WALLOWA-LOSTINE 83	S	73	1.00		73	1.00			73	1.00	
WALLOWA-LOSTINE 84	S	62	1.00		62	1.00			62	1.00	
WALLOWA HATCHERY	S	100	.99	.01	100	1.00			100	1.00	
IMNAHA RIVER 83	S	81	1.00		96	1.00			96	1.00	
IMNAHA RIVER 84	S	58	1.00		58	1.00			58	1.00	
IMNAHA HATCHERY	S	100	1.00		100	.90	.10		100	1.00	
MIDDLE FORK SALMON RIVER #	S	-			158	.97	.03		158	1.00	
SOUTH FORK SALMON RIVER	S	61	1.00		61	1.00			61	1.00	
YAKIMA RIVER 83	S	48	.99	.01	48	1.00			48	1.00	
YAKIMA RIVER 84	S	49	.99	.01	49	1.00			49	1.00	
ENTIAT RIVER	S	50	1.00		50	1.00			50	1.00	
WELLS HATCHERY	S	81	1.00		81	1.00			81	1.00	
METHOW RIVER	S	55	1.00		58	1.00			58	1.00	

Table 3 (continued).

STOCK	RACE	GLUCOSE PHOSPHATE ISOMERASE-3 N	100	120	92	GLUTAMATE OXALACETATE TRANSAMINASE-1,2 N	100	112	GLUTAMATE OXALACETATE TRANSAMINASE-3 N	100	77
BIG CREEK HATCHERY	W	100	1.00			-			100	1.00	
GRAYS RIVER	W	100	.99		.01	-			100	1.00	
ELOCHOMAN HATCHERY	W	100	.98		.02	100	1.00		100	1.00	
COWLITZ HATCHERY NATIVE	W	91	.96		.04	99	1.00		90	1.00	
COWLITZ HATCHERY CHAMBERS	W	95	.96		.04	80	1.00		100	1.00	
COWLITZ HATCHERY SKAMANIA	S	90	.98		.02	90	1.00		90	1.00	
EAGLE CREEK HATCHERY	W	98	1.00			100	1.00		100	1.00	
" " "	S	80	1.00			80	1.00		-		
MARION FORKS HATCHERY	W	100	1.00			-			100	1.00	
THOMAS CREEK 83	W	100	1.00			-			-		
THOMAS CREEK 84	W	55	1.00			-			55	1.00	
WILEY CREEK	W	100	1.00			-			100	1.00	
SOUTH SANTIAM HATCHERY	S	97	.95		.05	47	.94	.06	97	1.00	
CALAPOOYA RIVER 83	W	100	1.00			-			-		
CALAPOOYA RIVER 84	W	47	1.00			47	1.00		47	1.00	
LEABURG HATCHERY	S	95	.96		.04	100	.99	.01	100	1.00	
SANDY RIVER	W	100	1.00			100	1.00		100	1.00	
WASHOUGAL HATCHERY	S	95	.92		.08	50	1.00		100	1.00	
HAMILTON CREEK	W	53	.98		.02	-			53	1.00	
WIND RIVER	S	50	.92		.08	-			50	1.00	
KLICKITAT RIVER	S	100	.98	.02	*	-			100	1.00	
FIFTEENMILE CREEK	W	82	1.00			-			-		
ROUND BUTTE HATCHERY	S	100	.99		.01	-			100	1.00	
JOHN DAY RIVER	S	100	1.00		*	-			78	1.00	
UMATILLA RIVER	S	100	1.00			100	1.00		-		
UMATILLA HATCHERY	S	100	1.00			-			100	.98	.02
TUCANNON RIVER	S	113	1.00			103	1.00		103	1.00	
GRANDE RONDE RIVER 83	S	50	1.00			50	1.00		50	1.00	
GRANDE RONDE RIVER 84	S	110	.99	.01		110	1.00		60	1.00	
WALLOWA-LOSTINE 83	S	73	1.00			36	1.00		-		
WALLOWA-LOSTINE 84	S	62	1.00			-			62	1.00	
WALLOWA HATCHERY	S	100	1.00			100	1.00		100	1.00	
IMNAHA RIVER 83	S	96	1.00			86	1.00		96	1.00	
IMNAHA RIVER 84	S	58	1.00			58	1.00		58	1.00	
IMNAHA HATCHERY	S	100	1.00			100	1.00		83	1.00	
MIDDLE FORK SALMON RIVER #	S	277	.99								
SOUTH FORK SALMON RIVER	S	61	.99	.01		-			-		
YAKIMA RIVER 83	S	48	1.00			48	1.00		48	1.00	
YAKIMA RIVER 84	S	49	1.00			49	1.00		49	.98	.02
ENTIAT RIVER	S	50	1.00			50	1.00		-		
WELLS HATCHERY	S	81	.98	.01	.01	50	1.00		100	.99	.01
METHOW RIVER	S	58	.96	.04		-			58	1.00	

Table 3 (continued).

STOCK	RACE	ISOCITRATE DEHYDROGENASE					LACTATE DEHYDROGENASE-4				MALATE DEHYDROGENASE-1,2			
		N	100	40	120	71	N	100	76	111	N	100	140	70
BIG CREEK HATCHERY	W	98	.70	.14	*	.16	100	.96	.04		100	1.00		
GRAYS RIVER	W	94	.69	.12		.19	100	.80	.20		100	1.00		
ELOCHOMAN HATCHERY	W	89	.75	.13	.01	.11	99	.85	.15		100	.99		.01
COWLITZ HATCHERY NATIVE	W	90	.68	.12	.01	.19	99	.90	.10		99	1.00		
COWLITZ HATCHERY CHAMBERS	W	100	.65	.16	.02	.17	100	.90	.10		100	.99		.01
COWLITZ HATCHERY SKAMANIA	S	88	.66	.14	.01	.19	90	.88	.12		90	1.00		
EAGLE CREEK HATCHERY	W	95	.64	.20	.06	.10	100	.92	.08		100	1.00		
" " "	S	94	.70	.12	.03	.15	80	.78	.22		70	1.00		
MARION FORKS HATCHERY	W	94	.64	.13	.02	.21	100	.53	.47		100	1.00		
THOMAS CREEK 83	W	58	.72	.04		.24	100	.60	.40		50	.98		.02
THOMAS CREEK 84	W	52	.73	.12		.15	55	.71	.29		55	.98		.02
WILEY CREEK	W	-					100	.55	.45	.01	100	1.00		
SOUTH SANTIAM HATCHERY	S	89	.70	.18	.02	.10	96	.80	.20		94	.99		.01
CALAPOOYA RIVER 83	W	68	.74	.04	.01	.21	98	.41	.59		100	.99		.01
CALAPOOYA RIVER 84	W	46	.71	.12		.17	47	.48	.52		47	1.00		
LEABURG HATCHERY	S	97	.62	.19	.05	.14	100	.88	.12		90	1.00		
SANDY RIVER	W	97	.74	.13		.13	100	.90	.10		100	1.00		
WASHOUGAL HATCHERY	S	95	.64	.21	*	.15	99	.80	.20		100	1.00		
HAMILTON CREEK	W	50	.72	.13		.16	53	.88	.12		53	1.00		*
WIND RIVER	S	42	.66	.18		.16	50	.79	.20	.01	50	1.00		*
KLICKITAT RIVER	S	92	.71	.13	.01	.15	100	.60	.40		100	1.00		
FIFTEENMILE CREEK	W	82	.68	.09	.01	.22	81	.65	.35		82	1.00		
ROUND BUTTE HATCHERY	S	97	.68	.15		.17	100	.44	.56		100	1.00		
JOHN DAY RIVER	S	73	.71	.12	.01	.17	100	.30	.70		100	1.00	*	
UMATILLA RIVER	S	98	.66	.19		.15	99	.42	.58		100	.99	.01	
UMATILLA HATCHERY	S	90	.66	.12		.22	100	.57	.43		100	1.00		
TUCANNON RIVER	S	106	.64	.17		.19	112	.33	.67		113	1.00		
GRANDE RONDE RIVER 83	S	50	.70	.15		.14	49	.25	.75		50	.98	.02	
GRANDE RONDE RIVER 84	S	74	.72	.12		.17	109	.39	.61		110	1.00		
WALLOWA-LOSTINE 83	S	72	.75	.14		.12	73	.34	.66		73	.99		.01
WALLOWA-LOSTINE 84	S	57	.71	.12	*	.17	62	.36	.64		--			
WALLOWA HATCHERY	S	92	.67	.16		.17	100	.24	.77		100	1.00		
IMNAHA RIVER 83	S	96	.70	.14		.16	96	.29	.71		96	1.00		
IMNAHA RIVER 84	S	57	.72	.13		.15	58	.28	.72		58	1.00		
IMNAHA HATCHERY	S	87	.74	.08	*	.18	99	.39	.61		50	1.00		
MIDDLE FORK SALMON RIVER #	S	158	.67	.15		.18	277	.33	.66	.01	277	1.00		
SOUTH FORK SALMON RIVER	S	56	.64	.24		.12	61	.25	.75		61	1.00	*	
YAKIMA RIVER 83	S	46	.65	.15	.02	.18	48	.68	.32		48	1.00		
YAKIMA RIVER 84	S	46	.62	.16		.22	49	.61	.39		49	.99	.02	
ENTIAT RIVER	S	50	.60	.19	*	.21	50	.29	.69	.02	50	1.00	*	
WELLS HATCHERY	S	81	.66	.18		.16	81	.26	.74		81	.98	.02	
METHOW RIVER	S	53	.66	.14		.20	58	.29	.71		58	.99	.01	

Table 3 (continued).

STOCK	RACE	MALATE DEHYDROGENASE-3,4 N	100	83	110	90	MALIC ENZYME-3 N	100	85	MANNOSE PHOSPHATE ISOMERASE N	100	94	110
BIG CREEK HATCHERY	W	100	.92	.08			100	.80	.20	100	1.00		
GRAYS RIVER	W	99	.88	.10	.01	.01	90	.83	.17	100	1.00		
ELOCHOMAN HATCHERY	W	94	.89	.08		.03	100	.95	.05	57	1.00		
COWLITZ HATCHERY NATIVE	W	86	.91	.09			77	.62	.38	99	1.00		
COWLITZ HATCHERY CHAMBERS	W	99	.93	.07			98	.84	.16	100	1.00		
COWLITZ HATCHERY SKAMANIA	S	88	.82	.17	.01		85	.78	.22	90	1.00		
EAGLE CREEK HATCHERY	W	100	.89	.11			98	.83	.17	100	1.00		
" " "	S	95	.85	.15			-			90	1.00		
MARION FORKS HATCHERY	W	100	.96	.04			100	1.00		76	1.00		
THOMAS CREEK 83	W	97	.93	.07			80	1.00		-			
THOMAS CREEK 84	W	46	.93	.07			55	1.00		55	1.00		
WILEY CREEK	W	97	.90	.10	*		100	1.00		100	1.00		
SOUTH SANTIAM HATCHERY	S	95	.91	.07	.02		92	.96	.04	-			
CALAPOOYA RIVER 83	W	89	.99	.01			-			50	1.00		
CALAPOOYA RIVER 84	W	46	.96	.04			47	1.00		47	1.00		
LEABURG HATCHERY	S	100	.84	.13	.03		100	.96	.04	100	1.00		
SANDY RIVER	W	98	.92	.08	*		95	.88	.12	100	1.00		
WASHOUGAL HATCHERY	S	94	.82	.18			92	.82	.18	-			
HAMILTON CREEK	W	51	.89	.06	.04	.01	53	.89	.11	53	1.00		
WIND RIVER	S	49	.96	.04			50	.84	.16	50	1.00		
KLICKITAT RIVER	S	91	.91	.06	.02	.01	100	1.00		100	1.00		
FIFTEENMILE CREEK	W	82	.97	.01	.02		50	.94	.06	-			
ROUND BUTTE HATCHERY	S	98	.96	.04	*		100	1.00		100	1.00		
JOHN DAY RIVER	S	100	.99	*	*	*	50	1.00		100	1.00		
UMATILLA RIVER	S	100	.98	*	.02		100	1.00		100	1.00		
UMATILLA HATCHERY	S	100	.98	.01	.01		100	1.00		50	1.00		
TUCANNON RIVER	S	112	.98	.01	.01		113	1.00		-			
GRANDE RONDE RIVER 83	S	50	.99	.01			50	1.00		-			
GRANDE RONDE RIVER 84	S	110	.99	*		.01	110	1.00		50	1.00		
WALLOWA-LOSTINE 83	S	73	.95	.01	.04		73	1.00		73	.99	.01	
WALLOWA-LOSTINE 84	S	62	.95	.01	.04	.01	62	1.00		62	1.00		
WALLOWA HATCHERY	S	100	.96	.01	.03		100	1.00		100	1.00		
IMNAHA RIVER 83	S	96	1.00				94	1.00		96	.98	.01	.01
IMNAHA RIVER 84	S	58	1.00				58	1.00		58	1.00		
IMNAHA HATCHERY	S	100	1.00				100	1.00		100	1.00		
MIDDLE FORK SALMON RIVER *	S	277	.98	.02			-			277	1.00		
SOUTH FORK SALMON RIVER	S	61	.98		.02		61	1.00		61	1.00		
YAKIMA RIVER 83	S	48	.98	.02	.01		48	1.00		48	1.00		
YAKIMA RIVER 84	S	49	1.00				49	1.00		49	1.00		
ENTIAT RIVER	S	50	.99	*	*		40	1.00		50	1.00		
WELLS HATCHERY	S	76	.99		.01		76	1.00		81	1.00		
METHOW RIVER	S	58	.98	.01	.01		58	1.00		58	.99	.01	

Table 3 (continued).

STOCK	RACE	PEPTIDASE GLYCYL-LEUCINE					PEPTIDASE LEUCYL-GLYCYL-GLYCINE				PHOSPHOGLUCOMUTASE-2			
		N	100	110	85	95	N	100	129	74	N	-100	-140	-85
BIG CREEK HATCHERY	W	100	1.00				100	1.00			100	1.00		
GRAYS RIVER	W	100	.99	.01			100	1.00			100	1.00		
ELOCHOMAN HATCHERY	W	99	1.00				90	1.00			100	1.00		
COWLITZ HATCHERY NATIVE	W	99	1.00				99	1.00			99	1.00		
COWLITZ HATCHERY CHAMBERS	W	100	1.00				100	1.00			100	1.00		
COWLITZ HATCHERY SKAMANIA	S	90	1.00				90	1.00			90	1.00		
EAGLE CREEK HATCHERY	W	100	1.00				100	1.00			100	1.00		
" " "	S	100	1.00				40	1.00			70	1.00		
MARION FORKS HATCHERY	W	90	.94	.06			85	1.00			100	1.00		
THOMAS CREEK 83	W	100	.99	.01			100	1.00			68	1.00		
THOMAS CREEK 84	W	55	.96	.04			55	1.00			55	1.00		
WILEY CREEK	W	100	.96	.04			100	1.00			100	1.00		
SOUTH SANTIAM HATCHERY	S	97	.94	.06			97	1.00			47	1.00		
CALAPOOYA RIVER 83	W	100	1.00				-				100	1.00		
CALAPOOYA RIVER 84	W	47	.99	.01			47	1.00			47	1.00		
LEABURG HATCHERY	S	95	.95	.05			100	1.00			95	1.00		
SANDY RIVER	W	100	.96	.04			100	1.00			100	1.00		
WASHOUGAL HATCHERY	S	100	.95	.01		.04	100	1.00			100	1.00		
HAMILTON CREEK	W	53	.97	.03			53	.99	.01		53	1.00		
WIND RIVER	S	50	1.00				50	1.00			50	1.00		
KLICKITAT RIVER	S	100	.91	.05	.04		60	1.00			100	.96	.04	
FIFTEENMILE CREEK	W	82	1.00				82	1.00			82	.98		.02
ROUND BUTTE HATCHERY	S	97	.93	.07			100	.99	.01		78	.99		.01
JOHN DAY RIVER	S	100	.91	.09			100	1.00			100	.96		.04
UMATILLA RIVER	S	98	.90	.10			100	1.00			100	1.00		
UMATILLA HATCHERY	S	100	.95	.05			100	.99	.01		100	1.00		
TUCANNON RIVER	S	112	.88	.11	*		112	1.00	*		113	.99		.01
GRANDE RONDE RIVER 83	S	50	.93	.04	.03		50	1.00			50	.99		.01
GRANDE RONDE RIVER 84	S	110	.90	.09	.01		110	.99		.01	110	1.00		
WALLOWA-LOSTINE 83	S	73	1.00				73	1.00			73	1.00		
WALLOWA-LOSTINE 84	S	62	.93	.07			52	1.00			62	.99	.01	
WALLOWA HATCHERY	S	100	.93	.06	.01		100	1.00			100	1.00		
IMNAHA RIVER 83	S	100	.97	.03			100	1.00			87	1.00		
IMNAHA RIVER 84	S	58	.94	.06			58	1.00			58	1.00		
IMNAHA HATCHERY	S	100	1.00	*			100	1.00			100	1.00		
MIDDLE FORK SALMON RIVER #	S	277	.96	.04			277	.99			277	1.00		
SOUTH FORK SALMON RIVER	S	61	.98	.02			57	1.00			61	1.00		
YAKIMA RIVER 83	S	48	.91	.09			48	1.00			48	.98	.02	
YAKIMA RIVER 84	S	49	.82	.18			49	1.00			49	1.00		
ENTIAT RIVER	S	49	.96	.04			40	1.00			50	1.00		
WELLS HATCHERY	S	81	.91	.09			81	1.00			61	1.00		
METHOW RIVER	S	58	.95	.05			58	1.00			58	1.00		

Table 3 (continued).

STOCK	RACE	PHOSPHOGLUCOMUTASE-1			SORBITOL DEHYDROGENASE			SUPEROXIDE DISMUTASE			
		N	-100	-115	N	100	195	N	100	152	48
BIG CREEK HATCHERY	W	100	1.00		100	1.00		98	.60	.40	
GRAYS RIVER	W	100	1.00		100	1.00		96	.68	.32	.01
ELOCHOMAN HATCHERY	W	100	1.00		100	1.00		98	.68	.32	
COWLITZ HATCHERY NATIVE	W	99	1.00		99	1.00		88	.61	.39	
COWLITZ HATCHERY CHAMBERS	W	100	1.00		100	1.00		100	.66	.34	
COWLITZ HATCHERY SKAMANIA	S	90	1.00		90	1.00		90	.78	.22	
EAGLE CREEK HATCHERY	W	100	1.00		100	1.00		99	.65	.35	
" " "	S	70	1.00		100	1.00		64	.74	.26	
MARION FORKS HATCHERY	W	100	1.00		100	1.00		97	.45	.55	
THOMAS CREEK 83	W	68	1.00		-			58	.58	.43	
THOMAS CREEK 84	W	55	1.00		55	1.00		55	.63	.37	
WILEY CREEK	W	100	1.00		100	1.00		100	.62	.38	
SOUTH SANTIAM HATCHERY	S	47	1.00		97	1.00		97	.72	.28	
CALAPOOYA RIVER 83	W	100	1.00		-			59	.57	.43	
CALAPOOYA RIVER 84	W	47	1.00		47	1.00		47	.59	.41	
LEABURG HATCHERY	S	95	1.00		100	1.00		97	.78	.22	
SANDY RIVER	W	100	1.00		100	1.00		99	.76	.24	
WASHOUGAL HATCHERY	S	100	.98	.02	93	1.00		96	.82	.18	
HAMILTON CREEK	W	53	1.00		53	1.00		53	.71	.29	
WIND RIVER	S	50	1.00		50	1.00		50	.70	.30	
KLICKITAT RIVER	S	100	1.00		100	1.00		99	.78	.21	.01
FIFTEENMILE CREEK	W	82	1.00		82	1.00		76	.93	.06	.01
ROUND BUTTE HATCHERY	S	78	1.00		-			100	.91	.05	.04
JOHN DAY RIVER	S	100	1.00		-			93	.96	.03	.01
UMATILLA RIVER	S	100	1.00		100	1.00		96	.95		.05
UMATILLA HATCHERY	S	100	1.00		100	1.00		100	.98	.02	
TUCANNON RIVER	S	100	.99	.01	113	1.00		113	.93	.06	.02
GRANDE RONDE RIVER 83	S	50	1.00		50	.93	.07	50	.90	.10	
GRANDE RONDE RIVER 84	S	110	1.00		110	1.00		110	.93	.01	.06
WALLOWA-LOSTINE 83	S	73	1.00		73	1.00		73	.95	.03	.02
WALLOWA-LOSTINE 84	S	62	1.00		62	1.00		62	.90	.03	.07
WALLOWA HATCHERY	S	100	1.00		100	1.00		100	.99		.01
IMNAHA RIVER 83	S	96	1.00		96	1.00		86	.95	.04	.01
IMNAHA RIVER 84	S	58	1.00		58	1.00		58	.90	.02	.09
IMNAHA HATCHERY	S	100	1.00		100	1.00		89	.91	.03	.06
MIDDLE FORK SALMON RIVER #	S	277	1.00		-			277	.91	.01	.08
SOUTH FORK SALMON RIVER	S	61	1.00		61	.99	.01	61	.89		.11
YAKIMA RIVER 83	S	48	1.00		48	1.00		47	.92	.04	.04
YAKIMA RIVER 84	S	49	1.00		49	1.00		49	.86		.14
ENTIAT RIVER	S	50	1.00		50	1.00		49	.96		.04
WELLS HATCHERY	S	61	1.00		-			81	.90	.01	.09
METHOW RIVER	S	58	1.00		58	1.00		58	.97	.01	.02

Table 4. Enzyme systems with similar and dissimilar isozyme gene frequencies between different year classes of chinook salmon from the same stream system. See Table 1 for enzyme system abbreviations,

Stocks and year classes	Enzyme systems with similar frequencies)P > 0.05)	Enzyme systems with statistically significant differences in gene frequencies (P < 0.05)
1983 Grande RONDE WILD SPRINGS VS. 1984 GRANDE RONDE WILD SPRINGS	SOD, MPI, PEP-GL, NDH-34, ACO, ADH, IDH, LDH-4, GPI-13H	PEP-LGG
1983 IMNAHA WILD SPRINGS VS. 1984 IMNAHA WILD SPRINGS	SOD, MPI, PEP-LGG, MDH-34, IDH, ACO, ADH, PEP-GL, LDH-4, LDH-5 GPI-13H	PGK-2
1983 WALLOWA/LOSTINE WILD SPRINGS VS. 1984 WALLOWA/ LOSTINE WILD SPRINGS	SOD, MPI, PEP-LGG, IDH, ACO, ADH, PEP-GL, LDH-4, LDH-5, GPI-13H	PGK-2, MDH-34
1983 METHOW WILD SPRINGS VS. 1984 METHOW WILD SPRINGS	SOD, LDH-5, MDH-34, LDH-4, ACO, PEP-GL, GPI-13H	MPI, PEP-LGG, IDH

Table 5. Enzyme systems with similar and dissimilar isozyme gene frequencies between year classes of steelhead from the same stream system. See Table 1 for enzyme system abbreviations.

Stocks and year classes	Enzyme systems with similar gene frequencies (P > 0.05)	Enzyme systems with statistically significant differences in gene frequencies (P (0.05)
1983 THOMAS CREEK WILD WINTERS VS. 1984 THOMAS CREEK WILD WINTERS	LDH-4, MDH-12, SOD PEP-GL, GPI-1, GPI-3, ME-3, PGM-1	ACO, IDH-34, MDH-34
1983 CALAPOOYA RIVER WILD WINTERS VS. 1984 CALAPOOYA RIVER WILD WINTERS	LDH-4, MDH-12, PEP-GL, GPI-1, GPI-3, PGM-1	IDH-34, MDH-34, SOD
1983 GRANDE RONDE WILD SUMMERS VS. 1984 GRANDE RONDE WILD SUMMERS	ACO, AGP, GPI-3, SOD, MDH-34, PEP-GL, CK, GPI-1, ME-3, PGM-1	IDH-34, LDH-4, MDH-12
1983 WALLOWA/LONSTINE WILD SUMMERS VS. 1984 WALLOWA/ LOSTINE WILD SUMMERS	IDH-34, LDH-4, MDH-34 SOD, CK, GPI-1, GPI-3, HE-3, PGM-1	ACO, PEP-GL
1983 IMNAGHA WILD SUMMERS VS. 1984 IMNAHA WILD SUMMERS	ACO, LDH-4, CK, GPI-1, GPI-3, MDH-12, MDH-34, ME-3, PGM-1	IDH-34, SOD
1983 YAKIMA WILD SUMMER VS. 1984 YAKIMA WILD SUMMERS	CK, IDH-34, LDH-4, ME-3, MDH-12, MDH-34, PEP-GL GPI-1, GPI-3, PGM-1	ACO, SOD

Table 6. Enzyme systems with similar and dissimilar isozyme gene frequencies between races of chinook salmon from adjacent stream systems. See Table 1 for enzyme system abbreviations.

Adjacent Stocks	Enzyme systems with similar gene frequencies (P > 0.05)	Enzyme systems with statistically significant differences in gene frequencies 1P < 9.05)
CARSON HATCH. SPRINGS VS. LITTLE WHITE SALON HATCH. SPRINGS	SOD, MPI, PEP-GL, LDH-4, LDH-5, ACO, PEP-LGG, GPI-13H, ADH	PGK-2, MDH-34
CARSON HATCH. SPRINGS VS. LEAVENWORTH HATCH. SPRINGS	SOD, MPI, PEP-GL, LDH-4, LDH-5, ACO, PEP-LGG, ADH, MDH-34, PGK-2, GPI-13H .	IDH
LITTLE WHITE SALMON HATCH. SPRINGS VS. LEAVENWORTH HATCH SPRINGS	SOD, MPI, PEP-GL, LDH-4, LDH-5, ACO, MDH-34, GPI-13H, ADH	PGK-2$ PEP-LGG
JOHN DAY N. FORK WILD SPRINGS VS. JOHN DAY MID-FORK WILD SPRINGS	SOD, PEP-LGG, IDH, ADA-1, ADH, PGK-2, PEP-GL, LDH-5, MDH-34, LDH-4, GPI-13H, ACO	MPI
JOHN DAY N. FORK WILD SPRINGS VS. JOHN DAY MAINSTEM WILD SPRINGS	SOD, MPI, PEP-LGG, IDH, ADA-l, ADH, PEP-GL, LDH-5, MDH-34, LDH-4, GPI-13H, ACO	
JOHN DAY MAINSTEM WILD SPRINGS VS. JOHN DAY MID. FORK WILD SPRINGS	SOD, PEP-LGG, IDH, ADA-l, ADH, PEP-GL, PEP-LGG, LDH-5, MDH-34, LDH-4, GPI-13H, ACO, ADA-l, ADH	MPI
1984 GRANDE RONDE WILD SPRINGS VS. WALLOWA/ LOSTINE WILD SPRINGS	SOD, PEP-LGG, PEP-GL, ACO, MDH-34, ADH, IDH, LDH-4, GPI-13H	MPI
1984 GRANDE RONDE WILD SPRINGS VS. TUCANNON WILD SPRINGS	SOD, PEP-GL, LDH-4, ACO, MPI, PEP-LGG, ADH, LDH-5, GPI-13H	MDH-34, IDH
1984 GRANDE RONDE WILD SPRINGS VS. IMNAHA WILD SPRINGS	SOD, PEP-GL, LDH-4, ACO, MPI, MDH-34, IDH, ADH, GPI-13H	PEP-LGG
1994 WALLWA/LONSTINE WILD SPRINGS VS. TUCANNON WILD SPRINGS	SOD, PEP-GL, LDH-4, ACO, PEP-LGG, MDH-34, LDH-5, MDH-34, GPI-13H	MPI, IDH, ADH, PGK-2

Table b(continued).

Adjacent Stocks	Enzyme systems with similar gene frequencies (P > 0.05)	Enzyme systems with statistically significant differences in gene frequencies (P < 0.05)
1984 WALLOWA/LOSTINE WILD SPRINGS VS. IMNAHA WILD SPRINGS	SOD, PEP-GL, LDH-4, ACO, MPI, PEP-LGG, MDH-34, ADH, PGK-2, LDH-5, IDH, GPI-13H,	ADH
1984 TUCANNON WILD SPRINGS VS. IMNAHA WILD SPRINGS	SOD, PEP-GL, LDH-4, ACO, PEP-LGG, LDH-5, GPI-13H, ADH	MPI, MDH-34, IDH, PGK-2
WENATCHEE WILD SPRINGS VS. ENTIAT WILD SPRINGS	SOD, MPI, PEP-GL, PEP-LGG, IDH, LDH-4, ACO, ADA, PGK-2, LDH-5, GPI-13H,	MDH-34
WENATCHEE WILD SPRINGS VS. METHOW WILD SPRINGS	SOD, MPI, PEP-GL, PEP-LGG, IDH, LDH-4, ACO, ADA, PGK-2, LDH-5, GPI-13H, ADH	MDH-34
ENTIAT WILD SPRINGS vs. METHOW WILD SPRINGS	SOD, MPI, PEP-GL, PEP-LGG, IDH, LDH-4, ACO, ADA, PGK-2, MDH-34, LDH-5, GPI-13H, ADH	
ROUND BUTTE HATCH. SPRINGS VS. WARM SPRINGS WILD SPRINGS	SOD, MPI, PEP-LGG, MDH-34, ADH, LDH-4, LDH-5, ACO, ADA-1	PGK-2, PEP-LGG IDH
EAGLE CR. HATCH. SPRINGS VS. CLACKAMAS WILD SPRINGS	PEP-LGG, MDH-34, ACO, ADH, PEP-GL, LDH-4, LDH-5, GPI-13H	SOD, MPI, IDH

Table 7. Enzyme systems with similar and dissimilar isozyme gene frequencies between races of steelhead from adjacent stream systems. See Table 1 for enzyme system abbreviations.

Adjacent Stocks	Enzyme systems with similar gene frequencies (P > 0.05)	Enzyme systems with statistically significant differences in gene frequencies (P < 0.05)
COWLITZ HATCH. NATIVE STK WINTERS VS. COWLITZ HATCH. CHAMBERS CR. STK WINTERS	ACO, AGP, GPI-3, LDH-4, MDH-34, SOD, CK, GPI-1 MDH-12, PEP-GL, PGM-1	MDH-12, ME-3
COWLITZ HATCH. NATIVE STK WINTERS VS. COWLITZ HATCH. SKAMANIA STK WINTERS	ACO, AGP, GPI-3, LDH-4, CK, GPI-1, MDH-12, PEP-GL, PGM-1	MDH-34, ME-3, SOD
COWLITZ HATCH. CHAMBERS STK WINTERS VS. COWLITZ HATCH. SKAMANIA STK WINT.	ACO, AGP, GPI-3, LDH-4 MDH-12, ME-3, CK, GPI-1, PEP-GL, PGM-1	MDH-34, SOD
GRAYS RIVER WILD WINTERS VS. ELOCHOMAN RIVER WILD WINTERS	ACO, AGP, GPI-3, LDH-4, PEP-GL, SOD, CK, GPI-1, PGM-1	IDH-34, MDH-12, ME-3, MDH-34
S. SANTIAM HATCH. SUMMERS VS. WASHOUGAL HATCH. SUMMERS	ACO, GPI-3, LDH-4, CK, ‘GPI-1, PGM-1	AGP, IDH-34 MDH-12, MDH-34, ME-3, PEP-GL, SOD
SOUTH SANTIAM WILD SUMMERS VS. LEABURG HATCHERY SUMMERS	ACO, AGP, GPI-3, ME-3, PEP-GL, SOD, CK, GPI-1, PGM-1	IDH-34, LDH-4, MDH-34
LEABURG HATCHERY SUMMERS VS. WASHOUGAL HATCHERY SUMMERS	GPI-3, PGM-1, SOD, CK, GPI-1, MDH-12	ACO, AGP, IDH-34, LDH-4, MDH-34, ME-3, PEP-GL
WIND RIVER WILD SUMMERS VS. KLICKITAT RIVER WILD -SUMMERS	ACO, MDH-12, MDH-34, SOD, AGP, CK, PGM-1	GPI-1, GPI-3, IDH-34, LDH-34, ME-3 PEP-GL
MID. FORK SALMON RIVER WILD SUMMERS VS. S. FK SALMON R. WILD SUMMERS	GPI-1, LDH-4, MDH-12, MDH-34, PEP-GL, SOD, AGP, PGM-1,	ACO, IDH-34
ENTIAT RIVER WILD SUMMERS VS. METHOW RIVER WILD SUMMERS	IDH-34, LDH-4, MDH-12, MDH-34, PEP-GL, SOD, CK, ACO, AGP, GPI-1, PGM-1, ME-3	GPI-3

Table 7(continued).

Adjacent Stocks	Enzyme systems with similar gene frequencies (P > 0.05)	Enzyme systems with statistically significant differences in gene frequencies (P < 0.05)
WELLS DAM HATCHERY SUMMERS VS. METHOW RIVER WILD SUMMERS	ACO, GPI-3, IDH-34, LDH-4, MDH-12, MDH-34, PEP-GL, AGP, CK, GPI-1, ME-3, PGM-1	SOD
ENTIAT RIVER WILD SUMMERS VS. WELLS DAM HATCHERY SUMMERS	GPI-3, IDH-34, LDH-4, MDH-12, MDH-34, PEP-GL, SOD, AGP, CK, GPI-1, ME-31 PGM-1,	ACO
TUCANNON RIVER WILD SUMMERS VS. WALLOWA-LOSTINE WILD SUMMERS	ACO, CK, GPI-3, IDH-34, LDH-4, PEP-GL, AGP, GPI-1, GPI-3, ME-3	MDH-34, SOD
TUCANNON RIVER WILD SUMMERS VS. GRANDE RONDE WILD SUMMERS	ACO, CK, GPI-3, IDH-34, LDH-4, PEP-GL, GPI-1, MDH-12, ME-3	AGP, MDH-34, SOD
TUCANNON RIVER WILD SUMMERS VS. IMNAHA RIVER WILD SUMMERS	ACO, CK, GPI-3, IDH-34, LDH-4, PEP-GL, MDH-34, AGP, GPI-1, GPI-3, ME-3, MDH-12	SOD
WALLOWA-LOSTINE WILD SUMMERS VS. GRANDE RONDE WILD SUMMERS	ACO, CK, GPI-3, IDH-34, LDH-4, PEP-GL, SOD, ME-3, PGM-1	AGP, MDH-34
WALLOWA-LOSTINE WILD SUMMERS VS. IMNAHA RIVER WILD SUMMERS	ACO, CK, GPI-3, IDH-34, LDH-4, PEP-GL, SOD, CK, AGP, GPI-1, GPI-3, ME-3, PGM-1	MDH-34
GRANDE RONDE WILD SUMMERS VS. IMNAHA RIVER WILD SUMMERS	ACO, CK, GPI-3, IDH-34, LDH-4, PEP-GL, MDH-34, SOD, GPI-1, MDH-12, ME-3, PGM- 1	AGP
THOMAS CREEK WILD WINTERS VS. CALAPOOYA RIVER WILD WINTERS	ACO, PEP-GL, AGP, MDH-12, MDH-34, SOD, CK, GPI-1, GPI-3, ME-3, PGM-1	LDH-4

Table 7(continued).

Stocks	Enzyme systems with similar gene frequencies (P > 0.05)	Enzyme systems with statistically significant differences in gene frequencies (P < 0.05)
THOMAS CREEK WILD WINTERS VS. WILEY CREEK WILD WINTERS	ACO, PEP-GL9 MDH-12, MDH-34,GPI-1, GPI-3, ME-3, PGM-1, CK	AGP, LDH-4, SOD
THOMAS CREEK WILD WINTERS VS. MARION FORKS WILD WINTERS	ACO, PEP-GL, AGP, CK, MDH-12, MDH-34, GPI-3, ME-3, PGM-1	GPI-1, LDH-4, SOD
CALAPOOYA RIVER WILD WINTERS VS. WILEY CREEK WILD WINTERS	ACO, PEP-GL, LDH-4, CK, GPI-1, GPI-3, MDH-12, ME-3, PGM-1	AGP, MDH-34, SOD
CALAPOOYA RIVER WILD WINTERS VS. MARION FORKS WILD WINTERS	ACO, PEP-GL, AGP, CK, LDH-4, MDH-34, GPI-3, MDH-12, ME-3, PGM-1	GPI-1, SOD
WILEY CREEK WILD WINTERS VS. MARION FORKS WILD WINTERS	ACO, PEP-GL, LDH-4, CK, GPI-3, MDH-12, ME-3, PGM-1	AGP, GPI-1, MDH-34 SOD
JOHN DAY N. FK WILD SUMMERS VS. JOHN DAY MID. FK WILD SUMMERS	CK, GPI-3, IDH-34, SOD LDH-4, MDH-34, PEP-GL	ACO
JOHN DAY N, FK WILD SUMMERS VS. JOHN DAY MAINSTEM WILD SUMMERS	ACO, IDH-34, MDH-12, MDH-34, PEP-GL	LDH-4, SOD
JOHN DAY MAINSTEM WILD SUMMERS VS. JOHN DAY MID. FK WILD SUMMERS	ACO, CK, GPI-3, IDH-34, MDH-12, MDH-34, PEP-GL, SOD	LDH-4

Table 8. Relative heterozygosity values for fall, summer and spring chinook, hatchery and wild chinook, winter and summer steelhead, and hatchery and wild steelhead.

CHINOOK		STEELHEAD	
STOCK	HETEROZYGOSITY	STOCK	HETEROZYGOSITY
Fall	0.098	Winter	0.095
Spring	0.077	Summer	0.088
Summer	0.122		
		Hatchery	0.091
Hatchery	0.097	Wild	0.090
Wild	0.075		

Table 9. Mean and range [] for meristic characters of steelhead stocks. Code for race is W for winter steelhead and S for summer steelhead.

STOCK	RACE	SCALES IN LATERAL SERIES	SCALES ABOVE LATERAL LINE	ANAL RAYS	DORSAL RAYS	PELVIC RAYS	PECTORAL RAYS	VERTEBRAE
Bl6 CREEK HATCHERY	(W)	129.35	23.79	11.50	10.88	9.90	13.90	64.50
		[123-143]	[21-26]	[11-12]	[10-12]	[9-10]	[13-15]	[63-66]
BEAVER CREEK HATCHERY	(W)	128.75	25.80	11.65	11.44	9.95	14.05	63.80
		[123-135]	[23-29]	[11-13]	[10-12]	[9-11]	[13-15]	[63-63]
COWLITZ HATCHERY NATIVE	(W)	126.10	23.84	11.40	11.56	10.00	14.30	63.30
		[120-132]	622-273	[10-12]	[11-13]	[10-10]	[14-15]	[61-66]
COWLITZ HIATCHERY CHMBERS	(W)	125.85	24.25	11.45	11.17	9.90	13.75	63.75
		[121-133]	[22-261	[11-12]	[10-12]	[9-10]	[12-15]	[63-65]
CDWLITZ HATCHERY SKMAMIA	(S)	132.50	26.10	11.40	11.40	9.95	14.40	63.90
		[125-143]	[22-29]	[10-13]	[11-12]	[9-11]	[13-15]	[63-65]
EAGLE CREEK HRTCHERY	(W)	126.84	24.79	11.89	11.47	9.95	14.05	64.32
		[118-133]	[23-28]	[11-13]	[11-12]	[9-10]	[13-15]	[63-651
EAGLE CREEK HATCHERY	(S)	127.05	24.42	11.40	11.40	9.95	13.75	64.50
		[120-138]	[22-28]	[10-131	[10-13]	[9-10]	[12-15]	[63-67]
MARION FORKS HATCHERY	(W)	133.11	27.00	11.05	11.24	9.89	14.11	65.26
		[127-143]	[24-30]	[10-12]	[11-12]	[9-10]	[13-15]	[64-67]
THOMAS CREEK	(W)	131.39	27.39	11.33	11.78	9.94	14.44	64.61
		[125-136]	[23-30]	[11-12]	[11-13]	[9-10]	[14-16]	[64-66]
WILEY CREEK	(W)	139.00	29.10	11.10	11.42	9.90	14.75	64.95
		[130-1501	[26-31]	[10-12]	[10-12]	[9-11]	[14-16]	[64-66]
CALAPODYA RIVER	(W)	135.85	27.85	11.05	11.40	9.80	14.30	64.70
		[127-143]	[25-30]	[10-121	[11-12]	[9-10]	[14-15]	[64-66]
MCKENZIE HATCHRY	(S)	133.30	24.25	11.70	11.70	9.90	14.15	64.85
		[128-138]	[23-28]	[11-12]	[11-13]	[9-10]	[12-16]	[64-66]
SANDY RIVER	(W)	134.80	27.32	11.75	11.60	9.85	14.05	65.15
		[125-146]	[25-31]	[11-13]	[9-10]	[9-10]	[13-16]	[64-66]
WASHOUGAL HATCHERY	(S)	133.25	26.53	11.50	11.00	10.00	14.75	65.05
		[126-144]	[24-30]	[11-13]	[10-12]	[10-10]	[14-16]	[64-66]
KLICKITAT RIVER	(S)	144.33	28.56	11.61	11.78	9.89	14.26	64.79
		[130-158]	[26-31]	111-121	[11-13]	[9-11]	[13-16]	[63-67]
FIFTEENMILE CREEK	(W)	147.29	29.94	11.55	11.65	9.85	14.20	64.70
		[138-159]	[28-33]	[11-12]	[11-12]	[9-10]	[14-15]	[63-66]
ROUND BUTTE HATCHERY	(S)	145.45	29.30	11.40	11.90	9.95	13.65	63.45
		[130-159]	125-341	[10-12]	[11-13]	[9-11]	[13-14]	[62-65]
JOHN DRY RIVER	(S)	145.90	30.10	11.45	11.55	9.65	13.95	64.20
		[133-163]	[28-33]	[11-12]	[11-12]	[9-10]	[13-15]	[62-66]
UMATILLA RIVER ‘83	(S)	153.26	30.95	11.45	11.80	10.05	14.15	64.50
		[140-162]	[27-34]	[10-13]	[11-13]	[10-111	[13-15]	[63-66]
UMATILLA RIVER ‘84	(S)	151.55	30.95	11.30	11.90	9.80	13.90	64.45
		[135-164]	[26-34]	[10-12]	[10-13]	[9-10]	[13-14]	[63-66]
UMATILLA HATCHERY STOCK	(S)	143.20	26.60	10.85	11.33	9.70	14.00	64.20
		[131-155]	123-291	[10-12]	[11-12]	[9-10]	[14-141	[63-65]
TUCANNON RIVER	(S)	147.71	32.29	11.29	11.57	10.00	13.86	65.14
		[135-1561	[27-35]	[11-13]	[11-12]	[10-10]	[13-15]	[64-66]

Table 9 (continued).

STOCK	RACE	SCALES IN LATERAL SERIES	SCALES ABOVE LATERAL LINE	ANAL RAYS	DORSAL RAYS	PELVIC RAYS	PECTORAL RAYS	VERTEBRAE
GRANDE RONDE RIVER '83	{S}	145.00	30.30	11.35	11.70	9.05	14.20	64.45
		[132-161]	[27-33]	[11-12]	[11-13]	[9-10]	[13-15]	[63-67]
GRANDE ROlDE RIVER '84	{S}	149.35	30.82	11.47	11.42	9.58	13.53	64.32
		[140-161]	[29-35]	[11-13]	[10-12]	[9-10]	[13-14]	[63-66]
WALLOWA-LOSTINE '83	{S}	147.65	30.76	11.56	11.76	9.76	14.29	64.00
		[140-158]	[28-35]	Kll-121	Kll-121	[9-11]	[14-151	[63-66]
WALLOWA-LOSTINE '84	{S}	147.22	30.88	11.65	11.74	9.74	14.00	64.25
		[137-164]	[28-34]	[11-12]	Kll-131	[9-10]	[13-15]	[63-66]
WALLOWA HATCHERY STOCK	{S}	146.47	29.17	11.42	11.40	10.00	14.00	64.00
		[132-157]	[26-32]	[10-12]	Ill-121	[10-10]	[13-15]	[63-65]
IMNAHA RIVER '83	{S}	150.55	30.04	11.55	11.75	9.85	14.45	64.25
		[140-162]	[27-34]	KII-121	Ill-131	[9-10]	[14-15]	[63-65]
IMNAHA RIVER '84	{S}	148.11	30.25	11.50	11.75	9.85	14.25	64.25
		[135-161]	[27-32]	KII-121	[11-13]	[9-10]	[14-15]	[63-65]
IMNAHA HATCHERY STOCK	{S}	148.21	28.89	11.47	11.75	10.00	14.26	64.47
		[136-158]	[27-31]	[11-13]	Kll-121	[9-11]	[13-16]	[63-65]
SOUTH FORK SALMON RIVER	{S}	151.10	31.75	11.70	11.65	10.05	14.15	65.15
		[140-164]	[28-34]	[11-12]	[10-12]	[9-11]	[13-15]	[64-67]
YAKIMA RIVER '83	{S}	150.83	31.27	11.17	11.67	9.92	14.00	64.42
		[135-165]	[29-34]	[11-12]	Kll-123	[9-10]	[13-15]	[62-67]
YAKIMA RIVER '84	{S}	153.70	32.45	10.95	11.70	9.85	13.90	64.25
		[134-165]	[28-35]	[10-12]	[11-12]	[9-11]	[13-15]	[62-66]
ENTIAT RIVER	{S}	149.20	29.50	11.60	11.85	9.80	14. lb	64.45
		[137-160]	[27-33]	[11-12]	[11-13]	[9-10]	[13-16]	[63-66]
WELLS DAM HATCHERY	{S}	147.80	29.45	11.45	11.56	10.00	14.00	63. 60
		[136-162]	[26-34]	[10-12]	[10-13]	[9-11]	[13-15]	Kbl-661
METHOW RIVER	{S}	149.61	31.13	11.44	11.83	9.89	13.78	64.11
		[140-162]	[28-36]	Kll-131	Kll-131	[9-10]	[13-14]	[63-65]

Table 10. Mean and range [] for meristic characters of chinook salmon stocks. Code for race is F for fall chinook, SUM for summer chinook and S for spring chinook,

STOCK	RACE	SCALES IN LATERAL SERIES	SCALES ABOVE LATERAL LINE	ANAL RAYS	DORSAL RAYS	PELVIC RAYS	PECTORAL RAYS	VERTEBRAE
COWLITZ HITCHERY #1	(S)	136.15	30.95	15.37	12.15	10.10	15.80	67.70
		1130-1451	[26-33]	[15-16]	[12-13]	[10-11]	[15-16]	[66-69]
COWLITZ HITCHERY #2	(S)	135.80	31.45	15.50	12.40	10.10	15.80	67.65
		[130-142]	[29-36]	[15-16]	[11-13]	[10-11]	[15-16]	[66-69]
COWLITZ HATCHERY	(F)	137.65	33.40	15.79	12.50	10.10	15.55	67.30
		[131-142]	[30-38]	[14-17]	[12-13]	[10-11]	[15-16]	[66-69]
KALAMA HATCHERY	(S)	138.53	30.68	15.75	12.75	10.05	15.80	68.70
		[132-146]	[28-33]	[15-17]	[12-131	[10-11]	[15-17]	[66-71]
KALAMA HATCHERY	(F)	138.00	31.30	lb. 15	12.55	9.95	15.75	67.50
		[130-146]	[29-34]	[15-17]	[12-14]	[9-10]	[15-17]	[66-69]
LEWIS HATCHERY	(S)	143.71	33.10	15.55	12.60	10.11	16.00	71.75
		[141-148]	[30-36]	[15-17]	[12-14]	[10-11]	[15-17]	[70-73]
LEWIS HATCHERY	(F)	136.30	30.75	16.00	12.85	10.00	15.55	68.13
		[132-142]	[29-33]	[15-171	[12-13]	[10-10]	[15-16]	[67-69]
CLACKAMAS RIVER	(S)	143.15	31.90	15.55	12.35	10.15	15.25	69.00
		[133-156]	[29-35]	[14-17]	Kll-131	[10-11]	[13-16]	[68-71]
EAGLE CREEK HATCHERY	(S)	139.15	30.60	15.65	12.60	10.35	15.75	68.30
		[132-145]	[28-33]	[15-16]	[12-14]	[10-11]	[15-17]	[67-69]
SOUTH SANTIAM HATCHERY	(S)	139.94	31.67	15.b5	12.53	10.25	15.75	68.40
		[134-1491	[29-34]	[15-17]	[12-13]	[10-11]	[15-17]	[67-70]
THOMAS CREEK	(S)	140.55	32.00	15.75	12.25	10.10	15.65	69.35
		1133"1481	[29-35]	[15-17]	[12-13]	[10-11]	[15-16]	[68-70]
MCKENZIE HATCHERY	(S)	142.10	32.30	15.50	12.55	10.15	15.90	66.75
		[135-151]	[30-36]	[14-17]	Kll-141	[10-11]	[15-17]	[67-70]
DEXTER HATCHERY	(S)	141.50	30.20	15.74	12.40	10.20	15.70	66.95
		[134-151]	[26-34]	[15-17]	[12-13]	[10-11]	[15-17]	[68-71]
SANDY RIVER	(F)	138.74	32.25	lb.05	12.39	10.00	15.60	68.30
		[132-145]	[30-34]	[15-17]	[12-13]	[9-11]	[15-17]	[67-69]
BOWWEVILLE HATCHERY	(F)	136.79	33.66	15.39	12.11	10.21	16.26	66.63
		[133-143]	[31-36]	[15-16]	[11-13]	[10-11]	[15-17]	[65-68]
ARSON HATCHERY	(S)	148.47	32.20	16.31	12.70	10.15	15.85	71.85
		[143-157]	[29-36]	[15-18]	[12-131	[10-11]	[15-171	[70-74]
LITTLE WHITE SALMON HITCH,	(S)	142.47	31.06	15.89	12.26	10.00	lb.05	71.84
		[139-148]	[28-34]	[14-17]	[12-13]	[10-10]	[15-17]	[70-73]
SPRING CREEK HATCHERY	(F)	134.67	33.26	15.12	11.95	10.05	lb.00	65.90
		[130-141]	r.30"371	[15-16]	[11-13]	[10-11]	[15-17]	W-663
KLICKITAT HATCHERY	(S)	145.05	31.25	16.00	12.61	10.05	16.10	71.35
		[139-152]	[28-35]	[15-17]	[12-13]	[10-11]	[15-17]	[68-73]
HOOD RIVER	(F)	137.58	31.75	15.71	12.21	9.86	15.31	66.29
		[132-146]	[30-34]	[15-17]	Kll-131	[9-10]	[15-16]	[67-70]
DESCHUTES RIVER	(F)	136.55	32.00	lb.25	12.30	10.10	15.80	67.40
		[130-144]	[30-34]	[15-17]	[12-13]	[10-11]	[15-17]	[66-70]
ROUND BUTTE HATCHERY	(S)	146.90	32.45	16.05	12.55	10.05	15.55	71.30
		[141-153]	[30-35]	[15-18]	[12-14]	[10-11]	[14-16]	[70-73]

Table 10 (continued).

STOCK	RACE	SCALES IN LATERAL SERIES	SCALES ABOVE LATERAL LIME	ANAL RAYS	DORSAL RAYS	PELVIC RAYS	PECTORAL RAYS	VERTEBRAE
JOHN DAY RIVER	{S}	147.50	32.55	15.55	12.45	10.00	15.20	72.00
		[141-157]	[29-35]	[15-17]	[12-14]	[10-10]	[14-17]	[71-74]
TUCANNON RIVER	{S}	142.80	31.74	15.95	13.00	10.05	lb. 00	71.45
		[138-155]	[29-34]	[15-17]	[12-14]	[10-11]	[15-17]	[69-74]
TUCANNON HATCHERY	{F}	143.32	32.05	16.20	12.50	10.05	15.90	68.00
		1137-1513	[29-35]	[15-17]	[12-14]	[9-11]	[15-17]	[67-69]
GRANDE RONDE '83	{S}	144.53	32.53	15.95	12.35	10.00	15.65	71.85
		1134-1501	[29-35]	[15-17]	[12-13]	[9-11]	[15-16]	[70-73]
GRANDE RONDE '84	{S}	141.57	29.71	15.91	12.73	10.09	14.89	72.00
		[135-151]	[27-31]	[15-17]	[12-14]	[9-11]	[14-161	[71-73]
WALLOWA-LOSTINE '84	{S}	*146.47*	30.65	16.00	12.94	10.12	15.59	71.82
		[140-154]	[28-33]	[15-17]	[12-15]	[10-11]	[15-16]	[71-73]
IMNAHA RIVER '84	{S}	149.25	33.30	15.95	12.00	10.15	15.50	*71.60*
		[142-158]	[31-37]	[14-18]	[12-14]	[10-11]	[15-17]	[70-73]
RAPID RIVER HATCHERY	{S}	145.80	31.05	lb. 15	12.80	10.05	lb.00	71.45
		[141-1521	[28-34]	[15-17]	[12-141	[10-11]	[15-17]	[70-73]
SALMON RIVER SAWTOOTH	{S}	152.65	32.40	lb.25	13.15	10.30	16.20	72.15
		[145-161]	[30-35]	[15-17]	[12-14]	[10-11]	[15-17]	[71-73]
McCALL HATCHERY	{SUM}	153.45	32.15	16.50	13.05	10.10	16.*15*	72.30
		[143-163]	[30-35]	[15-18]	[12-14]	[10-11]	[15-17]	[70-75]
YAKIMA RIVER	{S}	149.11	32.79	15.85	12.90	10.05	lb.05	71.75
		[142-161]	[30-36]	[15-17]	[12-14]	[9-11]	[15-17]	[70-73]
HANDORD REACH	{F}	*140.60*		*lb.35*	12.40	9.90	15.50	68.85
		6133-1451		[16-18]	Kll-131	[9-10]	[15-16]	167-711
PRIEST RAPID HATCHERY	{F}	137.47	32.00	16.00	12.35	9.95	15.45	68.45
		[131-144]	[29-35]	[15-17]	[12-13]	[9-10]	[14-16]	[67-70]
WENATCHEE RIVER	IS?	144.53	31.30	lb. 15	12.55	10.10	15.15	71.75
		[131-153]	[29-35]	[15-17]	[12-14]	[10-11]	[13-16]	[70-73]
LEAVENWORTH HATCHERY	{S}	146.95	30.10	16.25	12.40	10.30	16.20	72.20
		[141-155]	[28-32]	[15-17]	[12-13]	[10-11]	[15-17]	[71-74]
ENTIAT RIVER	{S}	146.50	31.95	lb.00	12.70	10.00	14.90	71.85
		[140-162]	[29-35]	[15-17]	[12-13]	[10-10]	[13-16]	[69-73]
WELLS DAH HATCHERY	{SUM}	139.39	31.85	15.53	11.89	10.20	15.65	*69.20*
		[134-146]	[30-34]	[15-16]	Kll-131	[10-11]	115-161	[67-71]
METHOW RIVER '84	{S}	148.16	32.37	16.05	12.45	10.10	15.85	72.20
		[142-1561	[29-35]	[15-17]	[12-14]	[10-11]	[15-17]	[71-74]
OKANAGAN RIVER	{SUM}	138.05	32.50	lb. *16*	12.39	9.90	15.55	*69.00*
		[134-150]	[30-34]	115-171	[12-13]	[9-10]	[14-16]	[68-71]

Table 11. Sample size, treatment, average length, average weight and condition factor of three size classes of juvenile steelhead trout used in feeding experiment.

GROUP SIZE	SAMPLE SIZE	TREATMENT	AVERAGE LENGTH (cm)	AVERAGE WEIGHT (G)	CONDITION FACTOR K
SMALL	20	FED	6.27	4.30	1.75
SMALL	20	STARVED	6.46	4.29	1.60
MEDIUM	10	FED	7.07	5.83	1.65
MEDIUM	19	STARVED	7.15	5.75	1.57
LARGE	20	FED	9.87	15.43	1.61
LARGE	20	STARVED	10.57	15.41	1.31